ET Toolbox
Evapotranspiration Toolbox for the Middle Rio Grande
A Water Resources Decision Support Tool

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Version 3.1


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Al Brower - Bureau of Reclamation Civil Engineer (retired), contract consultant for the Toolbox.

2 Introduction - About This Document

This documentation is intended to provide information on the data sources, calculations, and formulations of the many output products of the Agricultural WAter Resources Decision Support (AWARDS) system and the Evapotranspiration Toolbox (ET Toolbox). It also provides user guidance for navigating through these products located on the Internet.

This document was requested primarily by users of the products in New Mexico; therefore it is focused on the operations in the Middle Rio Grande. However, it does contain components that are valid in other AWARDS/ET Toolbox project areas.

This document was written using the LaTeX, pronounced lay-tek, typesetting program operating on a Unix based computer, and saved as a pdf document. Most of the figures are from a period of time in the summer of 2014, although there are exceptions. A few were produced with PC Windows software called SmartDraw.

This pdf document is written to more easily accommodate reading and printing using the Acrobet reader available on personal computers. Using an Internet accessible computer allows access to the numerous website products.

The embedded figures outlined in red on the computer monitor are static, dated when aspects of this document were written. Dynamic real-time figures and tables are available by clicking on the W outlined in blue on the computer monitor following the figure number. This will activate an Internet link via the users web browser to the AWARDS/ET Toolbox website. The address is: http://www.usbr.gov/pmts/rivers/awards/

However, accessing the website during the winter months may produce limited ET and stream flow results.

The website links to other organizations are outlined in blue on the computer monitor.

Since the AWARDS/ET Toolbox development is an on-going process, this document will be modified as related program changes and additions take place.

3 Purpose of the AWARDS/ET Toolbox

The primary purpose of the AWARDS/ET Toolbox system is to estimate high-resolution daily rainfall and water depletions (crop and riparian vegetation ET, and open water evaporation) within specified river reaches. This includes presentation of near real-time rainfall, ET, stream flow conditions, and water quality data as frequently as possible within a readily accessible Internet site. These data can be used by water managers, river operations and irrigation district personnel, the scientific and farming communities, and the general public who may be interested in the various levels of water management issues.

These daily and historic values are available for input into RiverWare, which is the river modeling and water accounting system used by the Upper Rio Grande Water Operations Model (URGWOM). The URGWOM is a multi-agency effort to develop a numerical computer surface water model that covers the Rio Grande from its headwaters in Colorado to Hudspeth County, Texas, the Conejos River, the Rio Chama including the San Juan Chama Project diversions, and the Jemez River. The purpose of URGWOM is to provide a daily water operations accounting tool that can be used for basin-wide water management and planning. The URGWOM address is: http://www.spa.usace.army.mil/Missions/CivilWorks/URGWOM.aspx (URGWOM).

The definition of a toolbox is "a case for carrying or storing hand tools". The intent of the AWARDS/ET Toolbox system is to provide tools to the user community that help define the supplies and demands upon the river system. This toolbox is the carrier for the "tools", and a storage medium for historic ET and related products.

4 Overview of the AWARDS and ET Toolbox

Toolbox (ET Toolbox) system is used for estimating daily water use requirements at a resolution useful for implementation in the Upper Rio Grande Water Operations Model (URGWOM). The URGWOM is a multi-agency effort to develop a numerical computer surface water model that will cover the Rio Grande from Colorado to Hudspeth County, Texas, Texas.

The purpose of the URGWOM is to provide a daily water operations accounting tool that can be used for basin-wide water management and planning. The goal of the ET Toolbox project is to develop a methodology for automatically inputting daily riparian and crop water use estimates, open water evaporation estimates, and rainfall estimates to the URGWOM. The initial development work is focused on the Middle Rio Grande area from Cochiti Dam to Elephant Butte reservoir in New Mexico. ET of riparian vegetation and irrigated crops, and open water evaporation, accounts for about 60 percent of the water depletions over this section of the Rio Grande.

Future expansion may include the area north of Cochiti Dam to the Colorado border, and south of Elephant Butte reservoir to Hudspeth County, Texas, TX. The current version of the ET Toolbox does include the Chama/Velarde area north of Cochiti Dam.

The Middle Rio Grande Conservancy District (MRGCD) divisions (diversions) as used within the AWARDS/ET Toolbox system are listed in the following table:

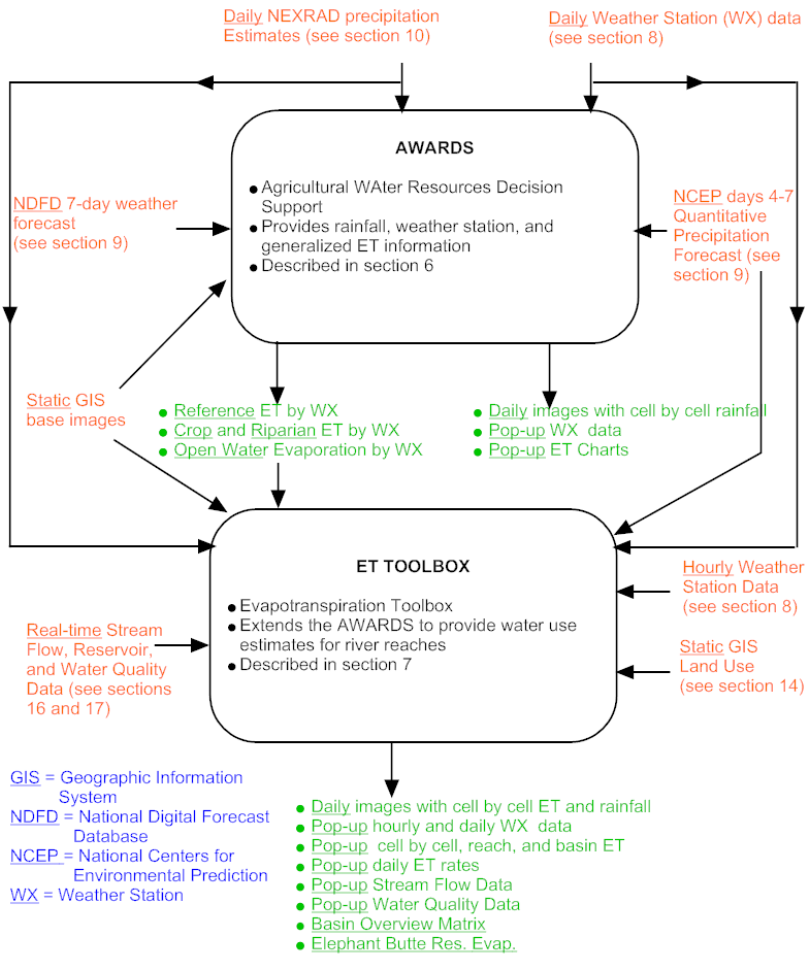
Cochiti
Ansostura (presented in the ET Toolbox as Albuquerque)
Isleta (presented in the ET Toolbox as Belen)
San Acacia (presented in the ET Toolbox as Socorro)

The newer river reaches boundaries as used within the ET Toolbox system are listed in the following table. These reaches were implemented on May 8, 2007. At that time the entire year 2007 was re-processed using these new reach delineations. Note that the Bernardo gage is non-operative. The Highway 346 gage is now used as a substitute.

River Reach 1	Cochiti Dam gage to San Felipe gage
River Reach 2	San Felipe gage to Alameda gage
River Reach 3	Alameda gage to Central Avenue gage
River Reach 4	Central Avenue gage to Isleta gage
River Reach 5	Isleta gage to Bernardo gage (Hwy. 346)
River Reach 6	Bernardo gage to San Acacia gage
River Reach 7	San Acacia gage to San Marcial gage (includes the Bosque Del Apache)
River Reach 8	San Marcial gage to north end of Elephant Butte Reservoir

4.1 Data Flow Diagram

The following diagram shows the overall data flow into and out of the AWARDS and ET Toolbox processes, including principal data inputs and resulting outputs. Note that many of the inputs are shared between them, and outputs from AWARDS are used in the ET Toolbox.



AWARDS and ET Toolbox Data Flow Diagram.

4.2 Computer and Temporal Considerations

The AWARDS/ET Toolbox operates on an IBM 3650 computer using the Community ENTerprise Operating System (CENTOS) which was derived from sources of Red Hat Enterprise Linux. This computer is owned by the Bureau of Reclamation and located in a Department of the Interior facility on the Denver Federal Center.

To ease the interfacing of various data feeds, all time-related information used throughout the ET Toolbox system is rectified to Mountain Standard Time (MST) throughout the year. Therefore, during Mountain Daylight Time (MDT) temporal scaling will be one hour behind clock time. This produces a little confusion for some users, but possibly not as much as the use of the more traditional Universal Coordinated Time (UCT).

4.3 AWARDS Overview

In late FY1997, Reclamation's Albuquerque Area Office became aware of a newly developed AWARDS system for the Lugert-Altus Irrigation district in southwest Oklahoma. The AWARDS system is an automated information system on the Internet designed to assist water managers and users by providing easy access to rainfall and crop water use estimates. AWARDS uses rainfall estimates based on data from the NEXRAD (NEXt generation weather surveillance RADar) radar systems and remote automated weather stations. The Albuquerque Area Office requested that the AWARDS system be implemented in the Rio Grande, primarily as the foundation for the development of the desired ET Toolbox.

The primary purpose of the AWARDS system is to improve the efficiency of water management and irrigation scheduling by proving guidance on when and where to deliver water, and how much to apply. The resulting ET charts from AWARDS provide this guidance. AWARDS systems that have been implemented east of the Continental Divide use the NEXRAD Hydroview Multisensor Precipitation Estimation System (MPE) program (radar and gage) hourly product produced by the National Weather Service's (NWS) River Forecast Centers (RFCs) on a 4 km grid scale.

However, for the Middle Rio Grande, the Pecos Basin, and Upper Rio Grande in Colorado, a different precipitation system was implemented on June 15, 2007. This is the Quantitative Precipitation Estimation and Segregation Using Multiple Sensors (QPESUMS) on an approximate 1-km grid. These QPESUMS (abbreviated to QPE) data are automatically collected into the AWARDS/ET Toolbox computer via the World Wide Web get (Wget) process from the National Severe Storms Laboratory (NSSL). The entire year back to January 1, 2007 was re-processed based on the QPE.

The National Digital Forecast Database (NDFD) weather forecasting data are used for calculating the seven-day forecast ET. This forecast is on a 5-km grid. Days 4-7 forecast rain are obtained from the National Centers for Environmental Prediction (NCEP) on a 1 degree by 1 degree resolution.

Automated weather stations in AWARDS system areas transmit surface weather data via

radio signal, phone, or satellite to local computer systems. The daily data are then automatically collected from the local computer systems, via File Transfer Protocol (FTP) or Wget, into the AWARDS/ET Toolbox computer.

The Modified-Penman method was used to calculate reference ET for each weather station through year 2011. Weather data used for calculating reference ET by this method was the maximum and minimum temperatures, average relative humidity, average wind speed, and solar radiation for the previous 24-hour Mountain Standard Time (MST) day.

Starting in 2013 the temperature based 1985 Hargreaves method is used to calculate reference ET.

Coefficients are applied to the reference ET to provide water use estimates for crops, riparian, and open water. These estimates, ET and rainfall forecasts, and effective rainfall are integrated into the images via pop-up charts.

Reservoir operators, water managers, and on-farm water users access the AWARDS system products via the Internet to make their operational decisions.

An AWARDS system brochure is available at: (Agricultural WAter Resources Decision Support (AWARDS)).

The address is: http://www.usbr.gov/pmts/rivers/awards/awards.html

In summary, these are the inputs and outputs of the AWARDS system:

Inputs
1) Daily NEXRAD (QPE) precipitation estimates
2) Daily and hourly weather station data
3) Static GIS base images
4) NDFD 7-Day forecast weather data (rainfall for days 1-4 only)
5) NCEP days 4-7 forecast rainfall

Outputs
1) Daily NEXRAD (QPE) rainfall images
2) Daily and hourly weather station data (hourly for information only)
3) Reference ET by weather station
4) Crop and riparian ET by weather station
5) Open water evaporation by weather station
6) ET charts containing past ET, forecast ET, NDFD, NCEP, and effective rainfall

Refer to AWARDS Products (section 6) for more information on the operation of the AWARDS system.

4.4 ET Toolbox Overview

The AWARDS/ET Toolbox computer first operates on the AWARDS system requirements, generating rainfall images and ET charts. It then expands these requirements into the finer resolution ET products to provide detailed volumetric water use estimates for the QPE cells and river reaches. As an extension of the AWARDS system, the ET Toolbox inputs the Reference ET, crop and riparian ET, and open water evaporation from the AWARDS system. It also uses the following components that are not applied in the AWARDS system:

1) Geographic Information System (GIS)land use
2) Real-time stream flow data
3) Real-time water quality data

Note that the effective rainfall component that is tabulated in the AWARDS ET charts is not used in the ET Toolbox. Future use depends upon accessing additional data sources and research.

The primary purpose of this effort is to estimate daily rainfall and water depletions for each QPE grid cell and the specified river reaches. These daily ET estimates and summary year-to-date cumulative ET estimates are available to users and water managers via the Internet.

GIS land use is added to the AWARDS product to specify crop, riparian, and open water acreage within each QPE grid cell (resolution about 1 km x 1 km) along the Middle Rio Grande. Prior to June 8, 2004 the Middle Rio Grande Land Use Trend Analysis (LUTA) Geographic Information System (GIS) data base for 1992/93 was used. After that date, a combination of the July 2000 IKONOS satellite imagery at 4 meter spectral resolution land use data set and the year 2001 Utah State University (USU) aerial photography at .5 meter resolution was used.

Beginning with year 2012, the agricultural vegetation classification component was obtained from the MRGCD crop reporting process via ARCGIS shape files. These classifications are from the prior year. As an example the 2012 irrigation season used the 2011 crop reporting. (An exception was year 2014 when the 2012 data were used.) Wherever the crop reporting exists, the IKONOS or USU is erased and the crop reporting is inserted. Since GIS land use classifications are critical for the Toolbox, this yearly reporting process improves the agricultural ET estimates.

All of the vegetation data sets are transposed to the QPE grid cell resolution. GIS methodologies are then used to compare these data sets to determine changes in the vegetation and water depletion over time. The most recent and accurate data sets that cover the areas of interest are chosen for the ET Toolbox.

Grid cells, with GIS acreages, are now assigned to near-by weather stations, and then either a single weather station, or multiple weather stations, are assigned to to each river reach. They can easily be reassigned whenever new weather stations are installed, land use data sets become available, or groupings are added or modified. If data from an assigned weather station is not available, then forecast data accessed from the NDFD for the prior day are used for the current day.

The station ET is applied to the grid cell acreage to get an acre-foot and cubic foot per second estimate of consumptive use for the cell.

The primary purpose of this effort is to estimate daily rainfall and water depletions for each QPE grid cell and the specified river reaches. These daily ET estimates and summary year-to-date cumulative ET estimates are available to users and water managers via the Internet.

Plots include total daily agricultural, riparian, and urban ET, and open water evaporation, as well as 5-day and 10-day running averages of daily ET to help detect water requirement trends. Also included is real-time access to data acquired from several agencies, including weather, stream gage, water quality, and radar rainfall estimates. Various links to other agencies for additional information are also provided.

The daily cumulative river reach ET estimates are also provided to the URGWOM for use by RiverWare, using a Data Storage System developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center.

Weather forecasting for the purposes of predicting ET for today and the next six days, and for substituting data for non-reporting weather stations, is accomplished by using the NDFD weather forecast parameters.

In summary, these are the inputs and outputs of the ET Toolbox system:

Inputs
1) Daily NEXRAD (QPE) precipitation estimates
2) Daily and hourly weather station data
3) Static GIS base images
4) Static GIS land use updated when available
5) NDFD 7-Day forecast weather data (rainfall for days 1-4 only)
6) NCEP days 4-7 forecast rainfall
7) Real-time stream flow data
8) Real-time water quality data

Outputs
1) Daily NEXRAD (QPE) rainfall images
2) Daily and hourly weather station data (hourly for information only)
3) Cell by cell, reach, and basin ET
4) Daily ET rates
5) URGWOM ET maps
6) Stream flow data
7) Water quality data
8) Basin Overview plots

Refer to ET Toolbox Products (section 7) for more information on the operation of the ET Toolbox.

4.5 Chronology of Events

The table on the following page shows some of the significant events that have occurred during the development of the AWARDS/ET Toolbox system, back to May, 2004:

DATE	EVENT
April 21, 2015	Changed information about NEXRAD source and processing. This is version 3.1.
Feb. 20, 2015	Minor edits to the documentation. This is version 3.01.
Feb. 12, 2015	Completed an update of the documentation representing the ET Toolbox as of this date. This is version 3.0.
Oct. 8, 2014	Added two water quality sites to the Water Quality Schematic.
Feb. 25, 2014	Updated the Avalon Reservoir data on the Pecos image.
Feb. 20, 2014	Cleaned out old year(s) data from the Weather Station Data / Plots image.
Feb. 18, 2014	Removed Candelaria Farms Field Sch. from the Reach 3 image.
Dec. 19, 2013	Installed a Water Quality Schematic Test Site
July 9, 2013	The Basin Overview Plots from June 13 through July 8, 2013 contain incorrect Otowi and San Marcial streamflow data.
May 23, 2013	Updated the Agricultural vegetation classifications from the 2011 MRGCD crop report acres to the 2012 MRGCD crop report acres, resulting in about a 1% increase in agricultural acres. All Toolbox ET values are now based on these acres starting January 1, 2013. There are no changes in the Riparian acres.
May 1, 2013	Removed "Tamarisk ET Model Research and Comparisons" from the website due to lack of data.
April 25, 2013	Removed "Candelaria Farms Field Scheduling on Alfalfa Field" from the website due to lack of data.
April 16, 2013	The AWARDS/ET Toolbox is converted from the SUSE Linux operating system to the Community ENTerprise Operating System (CENTOS) Linux.
April 11, 2013	On the Pecos River map fixed the Brantley Reservoir pop-up to display reservoir plot and data. The Avalon data are not available at this time.
April 11, 2013	The New Mexico State Climate Center weather data are zero for this year. When available again, we'll post a message here.

June 27, 2012	Upon advice from Middle Rio Grande research personnel, the Toolbox has started using the 1985 Hargreaves method for calculating Reference ET, which is a temperature based equation. All Toolbox ET values are now based on this method starting January 1, 2012. Lack of quality wind, solar, and humidity data, which are required by other methods, has forced this decision. Once quality data become available the a Toolbox may revert back to the ASCE Standardized method.
June 27, 2012	The growing degree day based crop coefficients have been replaced with coefficients developed by researchers in the Middle Rio Grande. A combination of temperature, stage-of-growth, and monthly processes is implemented. These processes can be altered as more research and discussion evolves. This has resulted in lower agricultural ET estimates and higher riparian and open water estimates.
April 4, 2012	The ET Toolbox is now using the ASCE Standardized method for calculating Reference ET. All Toolbox ET values are now based on this method starting January 1, 2012.
April 4, 2012	Changed the vegetation classifications: Agricultural = MRGCD crop reports from year 2011. Riparian = Combination of year 2000 IKONOS at 4 meter resolution and year 2001 Utah State Univ. at .5 meter resolution. This change also reduces the extent of the classifications to the river corridor, resulting in a significant reduction in riparian consumptive use.
Oct. 6, 2011	Improved the retrieval timing of the USGS streamflow data.
Sept. 28, 2011	The terminate (stop) date for all agricultural crops is now October 31. This affects Corn and Sorghum which prior to this change had earlier dates. Termination may also occur earlier as a function of the summation of growing degree days and the crop curve.
Sept. 22, 2011	The old Belen, North, and South schematics were removed.
Aug. 25, 2011	New stream flow schematic for the Socorro Division was implemented.
May 4, 2011	The delineation between river Reaches 5 and 6 was changed to reflect the demise of the Bernardo Rio Grande USGS stream flow measurement gage. The delineation is now at the State Hwy. 346 near the Bosque, Nm measurement gage.

Feb. 24, 2011	The ET Toolbox is now using the FAO-56 Penman-Monteith method for calculating Reference ET. All Toolbox ET values are now based on this method starting January 1, 2011.
Feb. 18, 2010	New stream flow schematics for the Rio Grande, and Cochiti, Albuquerque, and Belen Divisions were implemented. A new Water Management schematic showing reservoir data and Reach depletions, inflows, and gain/loss values was also implemented.
Aug. 27, 2009	The Tamarisk ET Model and Comparisons broke on September 9, 2008 due to lack of real-time hourly weather data at the South Bosque weather station. In August, 2009 these data became available from Salim Bawazir at NMSU. The model was rerun for all of 2008 and through July 24, 2009.
July 14, 2009	Data from the COAGMET station near La Jara, CO is no longer available since July 3, 2009.
June 2, 2009	Modified the crop coefficient for Open Water and Wet Sands. This is based on results of the "Open Water/Wet Soil Evaporation From The Rio Grande" final report dated April 2007. The report states that the Toolbox over predicts by 31% - however the Lidar study was done in unusually rainy and high flow conditions. This change reduces the Jensen Oct. 98 Open-Water monthly coefficients by 15% until a more realistic Lidar or other study can be accomplished. This change affects all Open Water and Wet Sands ET since January 1, 2009.
April 16, 2009	Reinstated the Colorado State Univ. COAGMET stations in the Upper Rio Grande area which are two stations near Center, Co and one station near La Jara, CO. The Blanca and San Acacio stations have no data.
April 8, 2009	Modified weather and stream flow data acquisition timing to better reflect when data are available.
April 3, 2009	Updated map positioning of some NMSCC weather stations.
Feb. 11, 2009	Installed Ladd S Gordon weather station in Reach 5.
Jan. 28, 2009	The AWARDS/ET Toolbox is converted from the Sun Solaris computer to an IBM System 3650 computer running the SUSE Linux operating system.
Oct. 8, 2008	Various edits, additional USBR Pumping Station information, and new Flow Diagram figures results in version 2.1.
Aug. 28, 2008	The Basin Overview Plots were modified. The green plots of Daily Consumptive Use are now Daily Net Water Use which is the Daily Consumptive Use minus Rain.

May 1, 2008 — New Stream Flow Products figure in the documentation results in version 2.0.1.

April 24, 2008 — Version 2.0 of the documentation is completed.

Dec. 10, 2007 — Removed Los Chavez Bosque weather station and installed Toni Barrow Farm weather station in Reach 5.

Oct. 23, 2007 — Revised the web-site New Mexico home page to allow more direct access to the Awards and ET Toolbox products.

Oct. 4, 2007 — Added forecast rain for forecast days 4-7. These data are Quantitative Precipitation Forecasts from the National Centers for Environmental Prediction Global Forecasting System model. The resolution of this forecasted days 4-7 rain is 1 degree by 1 degree (110km north-south by 90km east-west).

June 21, 2007 — Modified the New Mexico home page to allow a more direct link to the MRGCD Stream Flow Schematics. These also remain available from the New Mexico map.

June 15, 2007 — The old AWARDS/ET Toolbox based on the HRAP 4x4 km grid, 3-day Eta forecast, and old URGWOM river reach delineations was shut down. User's were automatically redirected to the new QPESUMS (abbreviated to QPE) site that is briefly explained in the May 8, 2007 notes, below.

June 14, 2007 — On June 15, 2007, the old AWARDS/ET Toolbox based on the HRAP 4x4 km grid, 3-day Eta forecast, and old URGWOM river reach delineations will be shut down. User's will automatically be redirected to the new QPESUMS (abbreviated to QPE) site that is briefly explained in the May 9, 2007 notes, below. Documentation of this new site is under way.

In the meantime, information for QPESUMS can be found at: http://www.nssl.noaa.gov/projects/qpesums/

Information for seven-day weather forecasting by the National Digital Forecast Database (NDFD) models can be found at: http://www.weather.gov/ndfd/

June 13, 2007 — Modified the AWARDS ET charts by replacing the QPF (Quantitative Precipitation Forecast) values with 3-day NDFD (National Digital Forecast Data).

Removed the Candelaria Farms Future 3-days Air Temperature and Relative Humidity plot since we no longer acquire hourly forecast data.

May 9, 2007 Numerous changes were made:

1. Quantitative Precipitation Estimation and Segregation
Using Multiple Sensors (QPESUMS) on an approximate 1-km grid.

2. Eight new URGWOM river reaches.

3. Seven-day National Digital Forecast Database (NDFD) weather forecasting models (although the rain is forecasted for only 3-days, and the solar radiation is approximated from min and max temperatures with coefficients). This forecast is on a 5-km grid.

4. URGWOM ET maps for each reach, with 1-week animation.

5. Improved ET estimates at 1-km cells that bisect reach boundaries.

6. Implemented open water evaporation estimates for the Rio Grande using the FLO2D model.

7. Estimating wet sands evaporation within the banks of the Rio Grande.

8. Estimating evaporation from Elephant Butte Reservoir

9. Estimating Tamarisk ET in the Bosque Del Apache using the Utah State Univ. model.

10. Removed cell rainfall postings.

11. Revised design of the Middle Rio Grande web site.

The old HRAP 4-km, old reaches, and 3-day Eta 12-km forecast site was still available until June 15, 2007.

June, 2006 Rio Chama/Velarde area window was created, using an estimated crop land distribution of 30% orchard, 30% alfalfa, and 40% pasture grass.

April 6, 2006 Generated historic ET summation information for each of the eight new URGWOM river reaches, based on the HRAP 4-km grid cells, for years 2000-2005.

April, 2006 Implemented a new stream flow schematic for the MRGCD Belen Division

May, 2005	Implemented Candelaria Farms Field Scheduling and soil moisture measurements at many MRGCD weather stations
Aug. 4, 2004	The NMSCC South Bosque (SBOS) hourly data is now included in the MRGCD Weather Station Network hourly pop-up image (fig. 20 in the documentation). This supports the ET Model for Tamarisk - see July 14, 2004.
July 27, 2004	MRGCD weather stations are added: CQFN Cisto Quintana Farm - NM - MRGCD - May 4,2004 CSBN Corrales Bosque - NM - MRGCD - May 4,2004 PDFN Prices Dairy Farm - NM - MRGCD - July 13,2004 BWWN Bosque Farms - NM - MRGCD - May 6, 2004 LCZN Los Chavez Bosque - NM - MRGCD - July 13,2004 GWFN Gus Wagner Farm - Nm - MRGCD - July 13,2004 The AWARDS/ET Toolbox is rerun each day from January 1. Therefore, data from the the NCEP Eta 12 km model is used until the station is active.
July 14, 2004	Added the Model for Daily Evapotranspiration of Tamarisk at the Bosque Del Apache, as detailed in a paper by Hipps and Hattori, USU.
June 29, 2004	Modified NEXRAD rainfall usage; now based on vegetative start and terminate dates rather than the entire year.
June 8, 2004	Now Using the newer GIS information for land classification, a combination of the 2000 IKONOS satellite imagery at 4 meter resolution and the 2001 Utah State University (USU) aerial photography at .5 meter resolution. The IKONOS is used from Cochiti Dam to Elephant Butte Reservoir headwaters (Reaches 1-7). The USU exists in a small part of Reach 3, Reaches 4, 5, and 6, and part of Reach 7. Wherever the USU exists, the IKONOS was erased and the USU was inserted. This replaces the 1992/93 Land Use Trend Analysis (LUTA), plus others. The Toolbox was/is rerun every day from January 1, 2004 to present with these newer GIS data for all vegetation groups. The historic runs, from 1975 through 2003, continue to be based on the LUTA, plus others.

June 7, 2004 Implemented the Nambe window.

June 3, 2004 The Daily ET Rate Tables now contain the GIS classification number.

May 26, 2004 MRGCD weather stations are added:

BBAN Bosque Bar - NM - MRGCD - Mar. 2, 2004
ASFN Adolf Sanchez Farm - NM - MRGCD - May 4, 2004

The AWARDS/ET Toolbox is rerun each day from January 1. Therefore, data from the the NCEP Eta 12 km model is used until the station is active.

5 Accessing the AWARDS and ET Toolbox

Access to the AWARDS/ET Toolbox home page is via the Internet at:

http://www.usbr.gov/pmts/rivers/awards/ (figure 1 W).

This page is titled "AWARDS - NEXRAD - ET Toolbox", which shows a map of the AWARDS and ET Toolbox project areas, and will henceforth be called the AWARDS/ET Toolbox home page.

Clicking on Middle Rio Grande provides the "NEXRAD Rainfall, Weather Station, and ET Products for the Rio Grande Basin in New Mexico" menu of available products:

1) Rio Grande Basin AWARDS System and ET Toolbox Project Areas
2) Historic Data
3) Archived Radar Precipitation Products (QPE)
4) Links to Real-Time and Forecasted Weather Data
5) Related Links

(figure 2 and it's continuation (figure 3 W).

The above will henceforth be called the New Mexico menu.

The website has evolved over the years based on the needs and special interests of various users, and therefore contains products that may not be of interest to everyone.

This documentation is focused on the Rio Grande Basin AWARDS System and ET Toolbox Project Areas component (No. 1 in the above table). The other products in the above table contain historic, archived, and interesting links, which may not be specifically addressed in this documentation.

Most of the products are available by clicking on "MAP with Quantitative Precipitation Estimation (QPE) and River Reaches"

NOTE: Many of the products are also available from the New Mexico menu.

5.1 MAP with Quantitative Precipitation Estimation (QPE) and River Reaches

Clicking on "MAP with Quantitative Precipitation Estimation (QPE) and River Reaches" pops-up an inter-active AWARDS/ET Toolbox window labeled "Image of QPESums latest day rain over middle Rio Grande". This image will henceforth be called the inter-active AWARDS/ET Toolbox image (figure 4 W) showing the specific windows outlined in white over the Middle Rio Grande. A colored elevation scale is provided by clicking on "see elev. terrain" (figure 5 W).

Windows generally contain lands that receive water from a diversion dam usually located at the northern most edge of the window. Exceptions are when multiple windows are needed for clarity, or when diversions are not defined. Other windows define the URGWOM river reaches one through eight. The color scale at the bottom of these inter-active AWARDS/ET Toolbox windows, and subsequent windows, represents the 24-hour rainfall intensities, in inches, that are mapped into each of the approximate 1 km x 1 km QPE grid cells.

The AWARDS system and ET Toolbox products are turned on and off by clicking on the box labeled "+ or - ETTool".

The ET Toolbox products are available by clicking the box labeled "+ ETTool". found throughout the various pop-up windows. Refer to ET Toolbox Products (section 7).

For the AWARDS system ET charts, click the box labeled "- ETTool". For these areas, refer to AWARDS Products (section 6).

5.2 Windows and Options Access

Within each window there are small rectangular boxes containing red lettering. These allow the user to quickly navigate the website:

1) Move between windows
2) Go to the AWARDS/ET Toolbox home page
3) Go to the New Mexico menu
4) Go to the parent window
5) Turn on/off the ET Toolbox vs AWARDS
6) Look at the past seven days
7) Perform a 1 week animation
8) Look at weather station data
9) Look at stream flow data
10) Look at River Reach summaries
11) Look at URGWOM ET maps
12) Etc.

6 AWARDS Products

The purpose of the AWARDS system is to provide generalized ET information for improving water use efficiency. The resulting rainfall estimate images and ET charts were developed to achieve this goal. Refer to the AWARDS/ET Toolbox Calculations (section 13) for information on the calculation of ET as used in the AWARDS system.

Access to the AWARDS products is from the New Mexico menu (figure 2 W) where the user should choose "MAP with Quantitative Precipitation Estimation (QPE) and River Reaches".

The resulting image (figure 4 W) shows the NEXRAD rainfall estimates throughout the Rio Grande. Each rainfall pixel is on an approximate 1 km scale. The 1 km rainfall is represented by the color intensity scale at the bottom of the image. These are daily (midnight-midnight) summations of hourly rain in inches. Refer to NEXRAD Precipitation Estimates (section 10 throughout the Rio Grande. for more information.

This image will henceforth be called the inter-active AWARDS image.

The diversion and river reach windows on the image are outlined in white.

By default, this is an image of the AWARDS products.

(To go to the ET Toolbox products when in AWARDS, click in the box labeled "+ ETTool")

NOTE: Many of the products are also available from the New Mexico menu.

6.1 River Reach and Chama/Velarde Windows

Clicking within a window in this inter-active AWARDS image allows access to the AWARDS products. This is an example image for river reach 5 labeled "Image of QPESums latest day rain over reach5 in the Belen area" (figure 6 W).

6.2 Daily Weather Station Data

Daily weather station data are available by clicking on the yellow or green plus signs (+) shown in many of the windows. This example shows the daily data at the Bosque Farms weather station for the period June 1 - July 10, 2014. (figure 7 W).

Refer to Automated Weather Station Data (section 8) for more information about the data, especially the Alternate Data Key.

6.3 ET Charts

ET charts are available by clicking into the QPE cells, defined by white dots at their corners, to pop-up a generalized ET chart showing the ET for all crops, riparian vegetation, and open water (Flow2DWater) that may be in the area. This example is for the QPE cell 2330 x 1485 in the River Reach 5 area served by the Bosque Farms weather station (figure 8 W).

No acreages or rainfall values are used in these calculations. The heading at the top of each chart shows the name of the weather station data that was used to calculate the daily crop water

use for the past four days, using the Hargreaves Reference ET Equation. Refer to Hargreaves Reference ET Calculation (section 12) for more information.

ET for seven forecast days, starting with today, are provided as calculated from the NDFD data. Refer to AWARDS/ET Toolbox Calculations (section 13) for more information.

The sum of ET to-date and the sum for the last seven and 14 days is shown. Each weather station is assigned to an array of QPE cells, therefore the ET portion of the charts may be identical for nearby cells. The start (plant) and terminate (harvest) dates are also given. Example date values 101 represents January 1 and 1231 represents December 31. These start and terminate dates may vary from north to south since they are based on temperature. Refer to Weather Forecasting (section 9) for more information.

Near the bottom of each chart is a posting of the NEXRAD rainfall estimates for the QPE cell. The "NEXRAD hrs avail" will always be 24, since the NEXRAD data are collected via the Local Data Manager (LDM) from the National Severe Storms Lab of NOAA on a daily bases. The total rain and calculated effective rain are provided. Refer to Effective Rainfall Estimates (section 11) for more information.

The columns headed NDFD are the forecast rainfalls for the next 3 days. The columns headed NCEP are the forecast rainfalls for days 4 through 7. Refer to Weather Forecasting (section 9) for more information.

The NEXRAD monthly total rain (since the beginning of the current year) and the QPE cell number are also provided.

6.4 Other Areas

Areas represented in the AWARDS system that do not have calculated ET but are available for rainfall viewing are Alcalde, Nambe, Truth or Consequences, Derry, El Paso NW, and El Paso SE. These can be accessed from the inter-active AWARDS image (figure 4 W).

NOTE: A more direct way to access these areas is via the New Mexico menu (figure 2 W) choosing "Rain, USGS Links, and Weather Data in Other Areas".

7 ET Toolbox Products

For operational and management purposes, the ET Toolbox provides products for river reaches and, as a special case, the Chama - Velarde area. This allows operation and management entities access to various consumptive use breakouts depending upon their requests and needs. Refer to the AWARDS/ET Toolbox Calculations (section 13) for information on the calculation of ET as used in the ET Toolbox system.

Access to the ET Toolbox products is from the New Mexico menu (figure 2 W) where the user should choose "MAP with Quantitative Precipitation Estimation (QPE) and River Reaches".

The resulting image (figure 4 W) shows the NEXRAD rainfall estimates throughout the Rio Grande. Each rainfall pixel is on an approximate 1 km scale. The 1 km rainfall is represented by the color intensity scale at the bottom of the image. These are daily (midnight-midnight) summations of hourly rain in inches. Refer to NEXRAD Precipitation Estimates (section 10) for more information.

The diversion and river reach windows on the image are outlined in white.

By default, this is an image of the AWARDS products. To get to the ET Toolbox products, click in the box labeled "+ ETTool".

(To go to the AWARDS products when in the ET Toolbox, click in the box labeled "- ETTool")

NOTE: Many of the products are also available from the New Mexico menu.

The image resulting from clicking on "+ ETTool" (figure 9 W) is similar to the AWARDS described image, except it contains more options by clicking in the boxes.

This image will henceforth be called the inter-active ET Toolbox image.

The diversion and river reach windows on the image are outlined in white.

(To go back to the AWARDS products when in the ET Toolbox, click in the box labeled "- ETTool")

7.1 River Reach and Chama/Velarde Windows

Clicking within a window in this inter-active ET Toolbox image allows access to the ET Toolbox products. This is an example image for river reach 5 labeled "Image of QPESums latest day rain over reach5 in the Belen area" (figure 10 W).

7.2 Daily Weather Station Data

Daily weather station data are available by clicking on the yellow or green plus signs (+) shown in many of the windows. This example shows the daily data at the Bosque Farms weather station for the period June 1 - July 10, 2014. (figure 7 W).

Refer to Automated Weather Station Data (section 8) for more information about the data, especially the Alternate Data Key.

7.3 Grid Cell Detail Tables

Grid cell detail tables are available by clicking into the QPE cells, defined by white dots at their corners, to pop-up a cell detail table showing the acres of each crop, riparian, open water, and urban species in the cell as defined by the GIS data set. Clicking within a grid cell (figure 10 W) will pop up a cell detail table showing the acres of each crop, riparian, open water, and urban species in the cell as defined by the GIS data set.

NOTE: There's currently no urban land use classification, therefore all urban values will be zero.

This example is for QPE cell 2330 x 1485 in the

River Reach 5 area served by the Bosque Farms weather station (figure 11 W).

The table includes the consumptive use for the last seven days and the next seven forecast days, and the totals by type, such as agricultural crops. Today is considered the first of the forecast days. Near the bottom of the table are the daily NEXRAD rainfall estimates for the cell. The URGWOM water use is the total consumptive use minus the NEXRAD rain. All quantities are in acre-feet. Those in parentheses are in cfs.

7.4 Reach Summary Products Menus

The ET Toolbox Summary for all reaches is accessible from the square box at the upper left corner of the inter-active AWARDS/ET Toolbox image (figure 9 W). The menu that pops-up is titled "ET Summary Products (To-Date) from Cochiti Gage to Elephant Butte Reservoir". This menu provides information similar to that described below for reaches, except there no daily ET rate tables.

Reach summary products, including tables and plots, are available by clicking in the appropriate boxes from this example, which is reach 5 (figure 10 W). As an example, clicking in the "River Reach 5 Summary" box from the Reach 5 image will pop-up this ET Summary Products (To-Date) menu (figure 12 W). The options available are a table, two types of plots, and daily ET rates by vegetative type. These are explained in the following five sub-sections.

7.4.1 Reach Summary Tables

Clicking on "Table" from the ET Summary Products (To-Date) menu (figure 12 W) provides the following table data for river reach 5 (figure 13 W). The classification source used for determining the consumptive is noted. A number of weather stations and NDFD model cells have been used for the calculations. The table shows, for each day, the total consumptive use in cubic feet per second (cfs) with a breakdown for each type (agricultural, riparian, open water, and urban). The daily rain is the NEXRAD rainfall estimate. The daily URGWOM water use is the consumptive use minus the NEXRAD rain. Five and 10 day running averages of the water use are also provided. The total URGWOM water use to-date in acre-feet since January 1 is included.

The forecast method (FM) column next to the date signifies the method used to calculate the consumptive use for seven forecast days, starting with today. An F indicates the 5-km grid NDFD model weather forecast parameters were used, including NDFD model forecast rainfall for the first three forecast days. In rare cases when the NDFD model data were not available, an A indicates that an average of the last three days were used. In this case, the forecast rainfall will be zero. At the bottom of the cell summary is a tabulation of the acres of each type. The fallow and idle types are not included in the consumptive use calculations, but are noted here for information only.

NOTE: The following description of Daily Flow Differences is currently not operational. It may be revised or deleted in the future.

Included in these summary tables are the daily flow differences, with five and 10 day running averages, as reported from real-time gage station data. Refer to Stream Flow Data for gage information (section 16).

Following is a listing of the stream flow gages used to calculate the daily flow differences in the ET Toolbox Summary and reaches 1 through 8 summaries. The daily flows are an average of all the readings (usually at 30-minute intervals) acquired throughout the day. Note that the Bernardo gage is non-operative. The Highway 346 gage is now used as a substitute.

ET Toolbox	Cross section at Cochiti Dam minus cross section at San Marcial
River Reach 1	Cross section at Cochiti Dam minus cross section at San Felipe
River Reach 2	Cross section at San Felipe minus cross section at Alameda
River Reach 3	Cross section at Alameda minus cross section at Central Avenue
River Reach 4	Cross section at Central Avenue minus cross section at Isleta
River Reach 5	Cross section at Isleta minus cross section at Bernardo (Hwy. 346)
River Reach 6	Cross section at Bernardo (Hwy. 346) minus cross section at San Acacia
River Reach 7	Cross section at San Acacia minus cross section at San Marcial (includes the Bosque Del Apache)
River Reach 8	Cross section at San Marcial minus cross section at Elephant Butte (future?)

7.4.2 Reach Summary Plots

There are two plots available from the ET Summary Products (To-Date) menu (figure 12 W).

7.4.2.1 Plot of last 14 and 7 forecast days - Total Consumptive Use, Agricultural, Riparian, Open Water, and Urban - also Rain The first plot (figure 14 W) contains a chart (in cfs) of the total daily consumptive use, affected by rain, and traces for each type, unaffected by rain. This is an example of river reach 5. The other river reaches and Cochiti gage to Elephant Butte Reservoir are similar. A bar chart of the NEXRAD rainfall estimate (in cfs) is also included. These data are plotted for the past 14 days, plus the seven forecast days (dashed traces), starting with today. A break in a trace indicates there were no data available for that period of time.

7.4.2.2 Plot of last 14 and 7 forecast days - Total Consumptive Use with Five and Ten-Day Running Averages - also Stream Gage The second plot for river reaches and Cochiti gage to Elephant Butte Reservoir contains a chart (in cfs) of the total daily consumptive use, affected by rain, and traces of the five and 10 day running averages of the total (figure 15 W). Also included are similar running average traces of the actual stream flow data from real-time gage stations, an attribute requested by Reclamation personnel. These data are plotted for the past 14 days, plus the seven forecast days (dashed traces), starting with today. A break in a trace indicates there were no data available for that period of time.

7.4.3 Daily ET Rate Table

Another system of tables is available from the ET Summary Products menu for each of the reaches (figure 12 W). These are the daily ET rates. They contain the daily ET rates for each species within each type for the reach, with a notation of the acres. The source of the classifications are the MRGCD agricultural crop reports and 2000/2001 IKONOS/USU riparian, noted as MRIU. The daily open water evaporation rates acreage can vary daily. Refer to Open Water Evaporation Estimates (section 15). Clicking on a species, such as Alfalfa, pops-up the table containing detailed information about the parameters used to calculate ET (figure 16 W). These include the acres, planting and termination dates (start and stop dates), reference ET, coefficient, ET, total water use, NEXRAD rain, and URGWOM water use, for each day from the planting date through yesterday. These are the data that are accumulated for the ET Toolbox and reach tables.

7.5 URGWOM ET Maps

These maps (figure 17 W example of reach 5) show the URGWOM ET that is mapped into each of the approximate 1km x 1km QPE grid cells. The ET has been reduced by the NEXRAD rain; therefore negative representation is possible. The color scale at the bottom of these maps provides the inches of daily URGWOM ET.

7.6 Basin Overview Plots

The Basin Overview Plots (previously named the Situation Analysis Matrix) are available from the New Mexico menu (figure 2 W). There are two matrixes that show the past, current (today), and predicted (future) status of the stream flow, rainfall, and consumptive use. These matrixes are With Present Division Rain (figure 18 W) and With Present Hourly Rain (figure 19 W). The area of consideration is from the Otowi gage to the San Marcial gage. The period for the past is seven days, and the predicted is seven days as determined by the NDFD forecast period. The past rainfall is the summation of NEXRAD over all the QPE grid cells for the area.

The daily consumptive use is the total of agricultural, riparian, open water, and urban for the area. This daily consumptive use was changed to daily net water use (daily consumptive

use minus rain) on August 28, 2008 as shown on the dynamic real-time images.

All units are in cfs, except the current (today) rainfall is in inches.

Currently there are no data available for predicting stream flow at the Otowi and San Marcial gages. The matrixes will be completed when these become available.

7.6.1 With Present Division Rain

The current (today) rainfall, as reported on the With Present Division Rain Matrix, (figure 18 W) is a average of the weather stations located in each division:

Division	ID	Averaged Weather Stations
Cochiti	COC	Pena Blanca, Cisto Quintana Farm, Angostura
Albuquerque	ABQ	Angostura, Corrales Bosque, Candelaria Farms, Bosque Bar, Prices Dairy Farm
Belen	BEL	Bosque Farms, Toni Barrow Farm, Jarales, Adolf Sanchez Farm, Ladd S. Gordon, and San Acacia
Socorro	SOC	San Acacia, Lemitar Nature Center, Gus Wagner Farm, Luis Lopez, North Bosque

The Present Division Rain matrix displays a color coded stacked bar when there is rain for each hour in each division.

7.6.2 With Present Hourly Rain

The current (today) rainfall, as reported on the With Present Hourly Rain Matrix, is an average of all the reporting MRGCD hourly weather station rainfall quantities since midnight (figure 19 W). Refer to section 8.1 for a listing of the MRGCD weather stations. If the MRGCD weather stations are not operational and forecast data is used, these hourly quantities will always be zero since the Toolbox does not get hourly forecast data.

7.6.3 Daily Archived Images

Archived matrixes are also available from the New Mexico menu (figure 2 W). Click on Daily Archived Images under the Basin Overview Plots heading. Then go to the desired year. The files in the directory are named SAdivrain for present division rain, and SAavgrain for present hourly rain. Each is followed by yymmda01.png.

8 Automated Weather Station Data

Weather data from three sources are used, or presented, within the AWARDS and ET Toolbox products. These data are used by the Toolbox to perform Reference ET calculations, and are very important for determining accurate daily ET values. The sources are:

Middle Rio Grande Conservancy District (MRGCD)
New Mexico Climate Center (NMSCC)
COlorado Gricultural Meteorological nETwork (CoAgMet)

Example of automated weather station used in the MRGCD network.

8.1 Middle Rio Grande Conservancy District

MRGCD weather station network presently consists of 17 sites. The initial Toolbox depended on data from the New Mexico State Climatology Center (NMSCC), and various NWS stations. Beginning in 1999, the MRGCD constructed a number of climate stations on agricultural lands specifically to provide data to the Toolbox. Data from these stations included temperature, precipitation, relative humidity, solar radiation, and wind speed. Data are supplied as an hourly mean, min, max, or total, as appropriate, as well as corresponding daily values.

Maintaining reliable input of weather station data from a variety of sources has proven to be one of the largest challenges for the Toolbox. At one time or another difficulties have been encountered getting data, or with the quality of the data, from virtually all sources. Physical maintenance of the stations has been a problem. MRGCD in particular has found it difficult to keep stations operating. With potentially as many as 20 sites, no more than 17 have ever

been in operation at one time. Telemetry problems, vandalism and animal damage, landowner issues, and normal deterioration of sensors are common. At present, only about four of the MRGCD stations still produce data. In lieu of non-operational MRGCD weather stations, the Toolbox activates the forecast weather data from the NDFD as described later in this section. It's anticipated the difficulties with weather data will soon be resolved.

Meanwhile, the Toolbox continues receipt of available hourly data automatically from this network via File Transfer Protocol (FTP) at 35 minutes past each hour. Available daily data are usually acquired at around 1:35 AM.

When viewing the following images note that if data sets are missing which occurs when a station is in-operative, yesterday's forecast data are substituted. There are no hourly and fuel moisture values in the forecast data.

Clicking on "WX. Stn. Data" from the inter-active AWARDS/ET Toolbox images (figure 4 W or figure 9 W) pops-up an image showing the location of the MRGCD weather station network with the yellow + signs and site ID's. The diagram on the right side of this image indicates what is available by clicking in each quadrant of a the + sign (figure 20 W).

NOTE: A more direct way to access the weather data is via the New Mexico menu (figure 2 W) choosing "Weather Station Data and Plots".

Clicking in the top left of the plus (+) signs pops-up the hourly weather data for the last 24-hours (figure 21 W). This is an example of the MRGCD Bosque Farms station.

Clicking in the top right of the plus (+) signs pops-up the temperature-humidity plot for the last seven days. These are developed only for the MRGCD weather stations (figure 22 W).

Clicking in the bottom right of the plus (+) signs pops-up the volumetric soil water content and rain for the last seven days. There is also a plot of the volumetric soil water content for all of the days of the year, to-date. These are developed only for the MRGCD agricultural weather stations, and some of these stations have in-operative soil moisture equipment (figure 23 W).

For the MRGCD weather stations located in bosque areas, clicking in the bottom right of the plus (+) signs pops-up the fuel moisture and rain for the last 14 days. These stations are: CSBN, BBAN, and LNCN (figure 24 W). Refer to the table below get the site names.

Clicking in the bottom left of the plus (+) signs pops-up the 24-hr (daily) gage precipitation accumulations that are used in estimating ET. These data are received around 1:12 AM MST from the MRGCD (figure 7 W). This is also an example of the MRGCD Bosque Farms station.

The table contains the the station name, source, elevation, and latitude/longitude location.

Data for the past seven days is shown in the upper part of the table consisting of maximum and minimum temperatures, average wind speed, relative humidity, rain, and solar radiation as measured by the station's sensors. The rain gage monthly totals since the beginning of the year are also tabulated. The bottom part of the table contains all of the data for each day since January 1st with the latest day first. Included in this listing is the calculated Hargreaves Reference ET. Refer to Hargreaves Reference ET Calculation (section 12) for more information.

When station data are unavailable for a day, alternate weather data from the NDFD weather forecast model from the previous day are used. Refer to Weather Forecasting (section 9) for more information. An alternate data key provides information on data that may have been

substituted. Example: In the Alternate Weather Data column ndfd1TS means the NDFD model 1st forecast day temperatures and solar radiation were used. In rare cases when the NDFD model data are also unavailable, data from a nearby weather station are used, with the 1st 4 character station ID posted under Alternate Weather Data. If that weather station is also unavailable, a second alternate station is used.

These 24-hour (daily) gage precipitation accumulations are also shown in yellow on the interactive AWARDS/ET Toolbox image, and sub-images, preceded by a + sign. The site ID's are shown if accumulations are not available. The plus (+) signs locate the stations by latitude and longitude. This is an example of the reach 5 sub-window (figure 10 W) and the pop-up Bosque Farms 24-hour data (figure 7 W).

The MRGCD weather stations are (from north to south), with the alternate station names:

Site Name	ID	1st Alternate	2nd Alternate	3rd Alternate
Pena Blanca *	PBLN	for5.172.099	CQFN	ANGN
Cisto Quintana Farm*	CQFN	for5.171.097	PBLN	ANGN
Angostura *	ANGN	for5.168.094	CQFN	CSBN
Corrales Bosque	CSBN	for5.167.092	ANGN	CFMN
Candelaria Farms *	CFMN	for5.165.089	CSBN	BBAN
Bosque Bar *	BBAN	for5.165.087	CFMN	PDFN
Prices Dairy Farm *	PDFN	for5.165.086	BBAN	BWWN
Bosque Farms	BWWN	for5.164.082	losl	PDFN
Toni Barrow Farm *	TBFN	for5.162.080	losl	JRLN
Jarales *	JRLN	for5.162.078	ASFN	TBFN
Adolf Sanchez Farm *	ASFN	for5.162.076	JRLN	IHFN
Ladd S Gordon *	LGFN	for5.161.074	ASFN	IHFN
San Acacia *	IHFN	for5.159.070	LGFN	LNCN
Lemitar Nature Ctr.*	LNCN	for5.159.068	IHFN	GWFN
Gus Wagner Farm *	GWFN	for5.159.066	LNCN	LLZN
Luis Lopez *	LLZN	for5.159.063	BANN	GWFN
North Bosque *	BANN	for5.159.061	LLZN	sbos

The stations in the above table with a * are inactive.

More information about the MRGCD can be found at: http://www.mrgcd.com/ (Middle Rio Grande Conservancy District)

8.2 New Mexico State Climate Center

In addition to the MRGCD network, previous day's meteorological data are also obtained via Wget from: http://weather.nmsu.edu/ New Mexico State Climate Center (NMSCC) at New Mexico State University.

The NMSCC has gone through cycles as well. Station locations have changed, sensor mountings have been modified, programming revised, and data feeds interrupted. Many of the NWS

sites are not well suited for agricultural ET calculations. For example, the official NWS Albuquerque station is affixed to the side of a concrete parking structure, surrounded for great distances on all sides by paving and buildings.

The 24-hr data are received at 5:40, 8:40, and 11:40 AM MST to get missing data. Only three sites, Alcalde, South Bosque, and North Elephant Butte Lake, if they were active, are used for ET estimation. Meanwhile, substituted NDFD forecast data are used. The Los Lunas station may be used as it is an alternate site for some MRGCD stations (see above MRGCD listing). The same criteria as detailed above for the MRGCD apply to the NMSCC weather data, except these are shown in green on all of the images. Also, only the South Bosque station, if it were active, has hourly data (these hourlys could potentially be used for Elephant Butte Reservoir evaporation estimates). The same table details, and rules for alternate weather data, apply as described above in section 8.1 for MRGCD data.

The NMSCC network weather stations are (from north to south), with the alternate station names:

Site Name	ID	Ownership	1st Alternate	2nd Alternate	3rd Alternate
Alcalde Agricultural Science Center *	alca	NMSCC	for5.178.109	PBLN	CQFN
Los Lunas Agricultural Science Center	losl	NMSCC	for5.163.081	TBFN	BWWN
South Bosque *	sbos	NMSCC	for5.158.059	BANN	LLZN
North Elephant Butte Lake *	elfb	NMSCC	for5.152.046	lake	
South Elephant Butte Lake *	lake	NMSCC	for5.150.046	elfb	
Derry Station *	derr	NMSCC	for5.149.038	elfb	
NMSU Turfgrass	nmsu	NMSCC	for5.158.026	lass	lasl
Las Cruces National Weather Service *	lasa	NWS	for5.158.026	lass	nmsu
NMSU Main Campus	lass	NMSCC	for5.158.026	nmsu	lasl
Leyendecker Plant Science Research Ctr	lasl	NMSCC	for5.158.024	lass	nmsu

The stations in the above table with a * are inactive.

Other NMSCC stations outside of the Rio Grande basin may show on some of the images.

8.3 Colorado State University Agricultural and Meteorological Network

Colorado State University Agricultural and Meteorological Network (COAGMET) http://www.atmos.colosta data are received via FTP at 6:18 AM and again at 10:18 AM MST to get missing data. The 24-hour precipitation accumulations from these stations (or site IDs if data are missing) are shown in blue, preceded by a + sign, on the Upper Rio Grande image accessed from the AWARDS/ET Toolbox home page (figure 1 (W). Clicking on Upper Rio Grande provides a menu with access to a map containing both NEXRAD precipitation and the COAGMET weather data (W). Data from the COAGMET meteorological stations are not used for the calculation of ET at this time. Expansion of the ET Toolbox into this area may occur in the future.

COAGMET sites (from north to south) are:

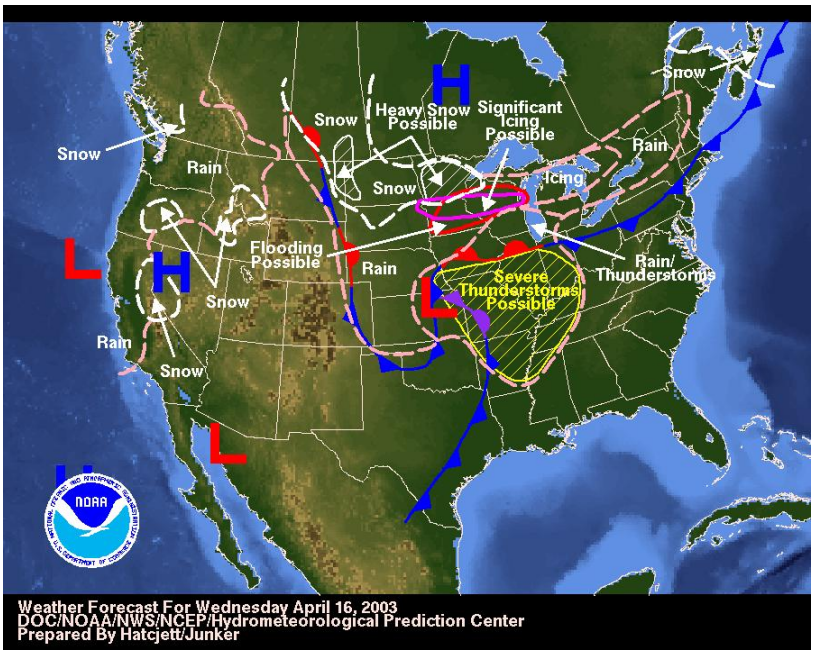
Site Name	ID
Center, CO	Coors Research Farm
Center, CO	CSU San Luis Valley Expt. Station
Blanca, CO	8 mi SW of Blanca
La Jara, CO	2 mi S of La Jara
San Acacio, CO	2 mi N of Mesita

8.4 Other Adjacent Areas With Weather Station Data

The Pecos River Basin Awards System images contain pop-up weather data from NMSCC sources. This area can be accessed from the AWARDS/ET Toolbox home page (figure 1 (W). Clicking on Pecos River provides a menu with access to a map containing both NEXRAD precipitation and NMSCC weather data (W).

The 24-hour precipitation accumulations stations (or site IDs if data are missing) are shown in green, preceded by a + sign. Data from the NMSCC meteorological stations in the Pecos River Basin are not used for the calculation of ET at this time. Expansion of the ET Toolbox into this area may occur in the future.

9 Weather Forecasting



Example Weather Forecast Map.

9.1 National Digital Forecast Database (NDFD)

The NDFD weather forecast parameters at an approximate 5-km grid resolution are used for the AWARDS and ET Toolbox ET forecasts for today and the next six days. See this WEB site for detailed information about the NDFD: http://www.nws.noaa.gov/ndfd/ (National Digital Forecast Database).

The NDFD data of the Southern Rocky Mountain subset are collected at 5:30 PM each day via World Wide Web get (Wget). These data include maximum and minimum temperatures, relative humidity, wind speed, precipitation, and sky cover. The forecast period is seven days. For example, the data acquired at 5:30 PM MST on March 7 (0030 UTC March 8) contains forecasts for March 8 through 14. An exception is the precipitation which is for three days (March 8 through 10). The projection frequency of each data element is described in the table (Description of NDFD Database Contents) within the above WEB site after clicking on "Access Data". These forecast data are assigned to nearby weather stations.

Here is an example of the 5-km NDFD grid (NDFD cell) for reach 2 (figure 25). The x,y numbering system (in red) is used to identify the approximate 5-km grid cells. Each weather station is cross referenced to a NDFD cell. The Angostura (ANGN) weather station is assigned to NDFD cell 168,94 and the Corrales Bosque (CSBN) station is assigned to cell 167,92. All

weather and ET forecasting for the stations, and forecast from the previous day if the station data are unavailable for today, are provided by the data from the assigned NDFD cells.

Note that there are no solar radiation data. Therefore solar radiation was calculated through 2010 with an algorithm developed from procedures described in FAO-56 (FAO) and The Astronomical Almanac (1998), using extraterrestrial radiation, clear sky radiation, maximum and minimum temperatures, and applicable coefficients. Starting in 2012, the solar radiation is calculated using sky cover and clear sky radiation using the algorithm from "Forecasting Solar Radiation" paper. Search for Forecasting Solar Radiation, and click on the pdf link "FORECASTING SOLAR RADIATION" by R. Perez for more information.

9.2 National Centers for Environmental Prediction (NCEP)

The forecast rain for days 4-7 (March 11 through March 14 in this example) are Quantitative Precipitation Forecasts from the Environmental Prediction Global Forecasting System model. The NCEP data are collected at 5:03 AM each day via World Wide Web get (Wget), with a resolution of 1 degree by 1 degree (110km north-south by 90km east-west). This equates to about a 20-km resolution. Like the NDFD data, these data are also assigned to nearby weather stations. See this WEB site for detailed information about the NCEP: http://www.ncep.noaa.gov/ (National Centers for Environmental Prediction).

10 NEXRAD Precipitation Estimates

Radar-based precipitation estimates are used in the AWARDS/ET Toolbox to offset ET demands. Accurate quantitative precipitation estimates (QPE) are obtained from The National Centers for Environmental Prediction (NCEP), an agency within NOAA. This next generation QPE is called Multi-Radar Multi-Sensor (MRMS) which is the most current product used in the AWARDS/ET Toolbox. It continues the National Severe Storms laboratory (NSSL) departure from radar-centric precipitation estimation and moves toward a multi-sensor approach focused on high-resolution integration of radar, satellite, model, and surface observations to produce very high-resolution precipitation estimates. For more information about QPE and MRMS, visit the WEB site for the NSSL at: http://www.nssl.noaa.gov/projects/mrms/ (W).

Data files in the GRIB2 (GRIdded Binary version 2) format are obtained from NCEP via the LDM (Local Data Manager) which runs continuously, getting the data for the continental US around 1:00 AM. At 4:15 AM these binary files are converted to NetCDF (network Common Data Form) format and data are extracted for New Mexico and southern Colorado. At 4:22 and 8:22 AM local time the computer converts the data from netcdf to text readable files, extracts only the 24-hour data for the prior day, and plots the 1/100 degree (approximately 1 km resolution) precipitation estimates onto the images.

This (figure 26 shows the overlapping radar coverage for NM, TX, and OK, and parts of CO, and AZ. The specific radars used in the QPESUMS product for the Middle Rio Grande are:

KABX	Albuquerque
KFDX	Cannon AFB
KHDX	Holloman AFB
KEPX	El Paso, TX

Rainfall (average depth) for each QPE grid cell located over the agricultural, riparian, and open water acreage along the Rio Grande is used in the water use calculations. These precipitation estimates are represented by a color spectrum placed at the bottom of each inter-active ET Toolbox window. This is an example of river reach 5 (figure 10 W).

11 Effective Rainfall Estimates

The effective precipitation process explained here is not currently used within the ET Toolbox. It is tabulated and appended to the AWARDS ET charts (figure 8 W) for reference only. It is not applied to the ET in the charts. Refer to AWARDS Products (section 6) for more information.

By definition, effective rainfall is that portion of rainfall that contributes to meeting the ET requirement of a crop (ASAE, 1983). Rainfall that neither leaves as surface runoff nor contributes to excess surface drainage may be effective precipitation in the context of irrigation management. Soil types, terrain slope, and soil moisture are not current components of the AWARDS system; therefore this simplified method apparently developed by the Bureau of Reclamation is implemented. The published method bases effective precipitation on increments of monthly rainfall. The relationships used are:

Table 1: Effective Rain As A Percent Of Total Rain (r)

Total Rain (in)	Effective Rain (%)
$r < .5$	100
$0.5 \leq r \leq 1.0$	95
$1.0 < r \leq 2.0$	90
$2.0 < r \leq 2.0$	85
$3.0 < r \leq 2.0$	75
$4.0 < r \leq 2.0$	55
$5.0 < r \leq 2.0$	35
$6.0 < r$	5

When future research provides a better method, possibly by using soil types, terrain slope, and remotely sensed soil moisture, then the above will be replaced and used within the ET Toolbox product to more accurately estimate daily water use requirements.

12 Hargreaves Reference ET Calculation

The Toolbox initially utilized a Modified-Penman Equation, along with many crop and riparian coefficients used provided by New Mexico State University (Bawazir and Sammis). This Penman calculation was referenced to grass (Eto)f in inches). This required daily weather data inputs consisting of maximum and minimum temperatures, relative humidity, solar radiation, and wind. In early 2012 the Eto calculation was modified to the ASCE Standardized method. Approximately mid-year 2012, the Eto calculation was again modified to use the 1985 Hargreaves method. Hargreaves is a simple temperature-based equation written in Fortran. figure 27 All ET values are now based on this method, and all of 2012 was recalculated back to January 1.

Lack of quality data for wind, solar radiation, and humidity forced this decision. When reliable data is again available, the Toolbox will resume use of the ASCE Standardized method for Eto calculation. Eto calculation is in inches.

The Eto calculation should be performed with actual climate data. However in recent years, due to problems with climate stations, the Toolbox has increasingly relied on NDFD data. While this is not the preferred approach, comparisons of forecast data and actual climate data have shown good agreement. Eto is forecast 7 days out but since forecast data is replaced daily, when it is used for Eto calculation in place of climate station data, the forecast is only one day in advance.

Calculations of Reference ET by other methods, for comparison purposes only, are also done with the results stored in internal files. These methods are:

1. Penman-Monteith Combination
2. 1982 Kimberly-Penman as used in Reclamation's Agrimet Program
3. Modified-Penman
4. Modified-Penman referenced to grass, an earlier version (Sammis et al. (1985))
5. American Society of Civil Engineer's (ASCE) Standardized Method based on the ASCE Penman-Monteith Equation will be a future addition

ET

13 AWARDS/ET Toolbox Calculations

13.1 Daily ET

Calculation of daily ET, as applied in the AWARDS system, and Daily Consumptive Use (DCU), as applied in the ET Toolbox, is initially based upon derivation of the Reference ET (Eto) and vegetative or open water coefficient (KC). The coefficient is dependent on either the Development Stage, Temperatures, or the Month of the year.

As a general rule, no ET is calculated (it it set to zero) before the start date or after the stop date.

A vegetation or open water coefficient (KC) is applied to the Eto to determine the daily ET in inches using the formula:

$$Daily\ ET = (KC)\ (Daily\ Eto)$$

where Daily Eto is the Reference ET as calculated by the Hargreaves equation. Refer to Hargreaves Reference ET Calculation (section 12). Graphs of coefficients are presented as Development Stage or Months. Refer to Veg. and Open Water Coefficients and Related Data

13.2 Coefficient (KC)

13.2.1 Coefficient (KC) based on Development Stage

On June 27, 2012 a new methodology was implemented for determining all crops and riparian vegetation coefficients. All ET estimates were re-calculated back to January 1, 2012. (Prior to January 1, 2012 ET estimates were based on coefficients determined from the Growing Degree Days method.) These coefficients are modified from the FAO-56 manual by researchers in the Middle Rio Grande, and are based on development stages, as noted in the following graphs. The start and end dates vary based on temperature at the local weather station, and therefore vary from north to south, with the northern areas starting later then the southern areas. The coefficient curves are represented by the blue lines on the graphs. The calculated Hargreaves Reference ET, as determined for each day from the 2011 North Bosque weather station, are shown by the red lines. The Crop ET's are products of the Reference ET and the coefficients. These are shown by the green lines. These graphs represent 2011 weather conditions at the North Bosque station and will vary from year-to-year and station-to-station.

Alfalfa (figure 28)
Pasture and Yard (figure 29)
Oats-Barley (figure 30)
Corn (figure 31)
Trees-Fruit (figure 32)
Trees-Nursery (figure 33)
Riparian (figure 34)
Vegetables, Row Crops, Garden (figure 35)

13.2.2 Coefficient (KC) based on Month

On June 27, 2012 a new methodology was implemented for determining open water evaporation coefficients, and all open water evaporation estimates were re-calculated back to January 1, 2012. (Prior to January 1, 2012 open water evaporation was based upon a study performed between Parker Dam and Imperial Dam on the Lower Colorado River.) The following graph shows the blue line coefficient curve. The calculated Hargreaves Reference ET, as determined for each day from the 2011 North Bosque weather station, is shown by the red line. The Open Water evaporation is product of the Reference ET and the coefficient. These are shown by the green line. These new coefficients are based on work done at New Mexico's Sandia National Laboratories at Cochiti and Elephant Butte Reservoirs. The Toolbox uses monthly averages of the two reservoirs. This newer method resulted in a yearly increase of about 60% over the prior Lower Colorado River study, addressing concerns that open water evaporation historically had been substantially under estimated by the ET Toolbox. This graph represents 2011 weather conditions at the North Bosque station and will vary from year-to-year and station-to-station. (figure 36) Refer to Open Water Evaporation Estimates (section 15).

The KC is interpolated from the curve represented in the graph. For example, a coefficient for open water would be 1.18 on July 15

13.3 Vegetative and Open Water Daily Consumptive Use (DCU) - ET Toolbox Only

Computer processes were developed to collect all of the required data sets and calculate the Daily Consumptive Use (DCU) in acre feet for each vegetative type (or open water) within each HRAP grid cell using:

$$Vegetative\,type\,DCU = (Daily\,ET)(Acres)/12$$

where Acres is the vegetative or open water acreage of the grid cell. Refer to GIS Land Classification (section 14).

13.4 Total Grid Cell DCU - ET Toolbox Only

All of the acre feet values are summed to arrive at an estimated consumptive use for each grid cell. The NEXRAD estimated daily accumulated rainfall (in acre feet) is then subtracted.

$$Total\,Grid\,Cell\,DCU = Sum\,of\,Vegetative\,type\,DCU's - Rainfall$$

13.5 River Reach and Diversion DCU) - ET Toolbox Only

All of the grid cell totals are summed for each river reach and diversion.

$$River\ Reach\ DCU = Sum\ of\ Total\ Grid\ Cell\ DCU\ values\ within\ the\ river\ reach.$$

$$Diversion\ DCU = Sum\ of\ Total\ Grid\ Cell\ DCU\ values\ within\ the\ diversion.$$

13.6 DCU Values in Cubic Feet Per Second - ET Toolbox Only

The DCU values in acre feet per day are also converted to flow in cubic feet per second (cfs) for use by water managers and in the URGWOM, where:

$$cfs = acre\ feet/1.98347$$

Toolbox.

14 GIS Land Classification

River front near the Bosque riparian research site.

14.1 Reaches 1-8

Prior to June 8, 2004 the Middle Rio Grande Land Use Trend Analysis (LUTA) Geographic Information System (GIS) data base for 1992/93 was used in the AWARDS/ET Toolbox system. After that date, a combination of the July 2000 IKONOS satellite imagery at 4 meter spectral resolution land use data set and the year 2001 Utah State University (USU) aerial photography at .5 meter resolution was used.

The IKONOS was acquired from the MRGCD and the New Mexico Interstate Stream Commission. The IKONOS is used from Cochiti Dam to Elephant Butte Reservoir headwaters (Reaches 1-8). The USU exists in a small part of Reach 3, Reaches 4, 5, 6, 7, and part of Reach 8. Wherever the USU exists, the IKONOS was erased and the USU was inserted. The USU has a less east-west extent than the IKONOS, basically following just the river corridor. Also, the USU coverage is mostly riparian, whereas the IKONOS is both agricultural and riparian.

Beginning with year 2012, the agricultural vegetation classification component was obtained from the MRGCD crop reporting process via ARCGIS shape files. These classifications are from the prior year - the 2012 irrigation season used the 2011 crop reporting etc. (An exception was year 2014 when the 2012 data were used.) Wherever the crop reporting exists, the IKONOS or USU is erased and the crop reporting is inserted. Since GIS land use classifications are critical for the Toolbox, this yearly reporting process improves the agricultural ET estimates.

Generally these are the crops that are reported:

1. Alfalfa
2. Pasture
3. Oats-Barley
4. Corn
5. Trees-Fruit
6. Trees-Nursery
7. Vegetables, Row Crops, Garden
8. Yard

Riparian classifications continue from the IKONOS and USU GIS as described above.

Regardless of the origin, GIS are transposed to the nominal 1 km QPE grid cell resolution for use in the ET Toolbox with the NEXRAD-based 24-hr rainfall estimates. An important component of the ET Toolbox is determination of the vegetative growth acreage of agricultural crops, riparian vegetation, and open water in each of the 1 km QPE grid cells. These data are then applied to the empirically derived ET to produce a daily volumetric water requirement for each QPE cell. Refer to ET Toolbox Calculations (section 13).

Additional year 2002 riparian GIS efforts by the Endangered Species (ES) Collaborative Program are now available. Comparisons of the LUTA, IKONOS, USU, and ES have been made and are available from the AWARDS/ET Toolbox staff.

There is a need to develop a methodology for updating the GIS riparian vegetation and open water indexing data to detect changes and update the ET Toolbox at least once during each annual growing season. The constraints are that the technology used must by cost permissive, timely, and sufficiently accurate (e.g. 90%) for use in water resources management.

14.2 Rio Chama/Velarde

The Rio Chama/Velarde area is north of the IKONOS and USU coverage. The MRGCD provided GIS acreage information of the agricultural lands which are shown as white polygons in this image, which were resolved to the 1 km QPE cells (figure 37 W). The MRGCD also provided a quick estimate of the agricultural acreage that is applied to the total acreage of each cell:

Crop	Percent
Alfalfa	30
Orchard	30
Pasture Grass	40

There are approximately 1460 1 km cells within the entire Reach 1-8 area, including the Rio Chama/Velarde.

15 Open Water Evaporation Estimates

The evaporation from open water and wet sands contributes significantly to the water depletion in the Middle Rio Grande valley. The Toolbox calculates evaporation based on the Hargreaves Reference ET using local weather data when available; otherwise forecast weather data. (section 12),Open Water monthly coefficients, (section 13), and the surface area to get the open water evaporation in acre-feet.

This methodology is applied to Rio Grande Evaporation, Elephant Butte Reservoir Evaporation, and Wet Sands Evaporation.

15.1 Rio Grande Evaporation

A 2-dimensional dynamic flood routing model named FLO-2D is used to estimate the daily surface area of the Rio Grande. Inputs are the real-time flow conditions provided from the USGS stream flow gaging system. Refer to Stream Flow Data (section 16) for information about the gaging system. More information about the FLO-2D model is available at: http://www.flo-2d.com/ (FLO-2D).

15.2 Elephant Butte Reservoir Evaporation

To find the daily reservoir evaporation value, real-time reservoir elevation data are acquired from the USGS. This elevation is then applied against an area-capacity table to get the water surface acreage of the reservoir.

Access to the Elephant Butte Reservoir evaporation is from the Reach 8 ET Toolbox image (figure 38 W). or via the New Mexico menu (figure 2 W) choosing " Elephant Butte Reservoir Evaporation".

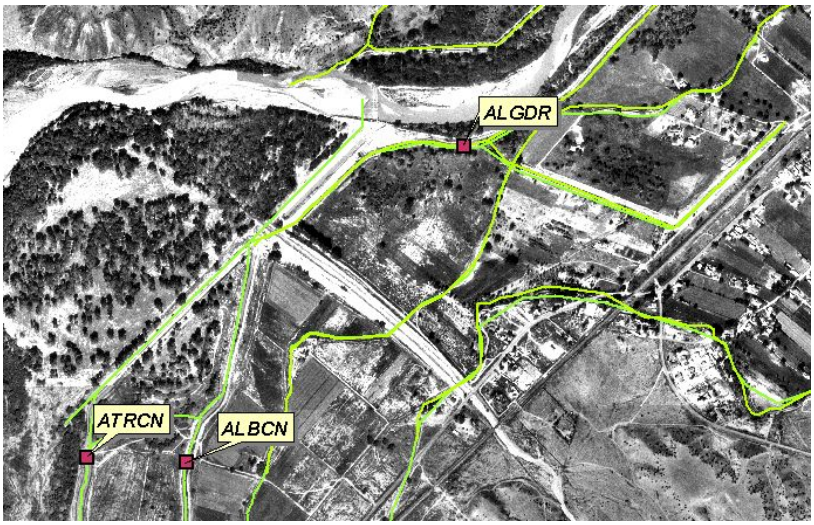
Clicking on Elephant Butte Reservoir evaporation provides an option menu (figure 39 W). The options available are Last 7 and 7 Forecast Day's Evaporation (figure 40 W), Daily Evaporation Rates (figure 41 W), and Plot of Elephant Butte Open Water Evaporation & Acres (year-to-date) (figure 42 W). The plot is from September 2007. There are also historic data available from the menu.

An improvement to the above process for determining reservoir evaporation was done in 2001 with a plan to use the results of the field research study in the Toolbox. The associated evaporation model is described in "Lake Evaporation Estimation in Arid Environments (Final Report)", dated July 2003, available at: http://www.iihr.uiowa.edu/wp-content/uploads/2013/06/IIHR430.pdf (University of Iowa) However, this model requires specific hourly weather data at and above the reservoir surface which are currently not available; therefore the model is presently not used in the Toolbox.

15.3 Wet Sands Evaporation

Currently, the determination of area of wet sands within the Rio Grande corridor is the difference between the bank-to-bank area minus the FLO-2D area. Evaporation is assumed to occur from the surface and shallow sub-surface area difference.

16 Stream Flow Data



Gage Station Products in the Angostura Dam Area.

As an enhancement to the ET Toolbox, users at the Middle Rio Grande Conservancy District and USBR requested near real-time graphs and text of stream flow conditions throughout the valley. This allows direct comparison of consumptive use estimates and stream flow, considering an approximate five day lag for water released at Cochiti Dam to arrive at the San Marcial gage. District personnel developed schematics of the diversions and return flows. All data sets, from the MRGCD, USGS, USACE, and USFWS, are automatically received into the Toolbox by various means at the top of each hour and at 30 minutes past each hour.

The gage naming criteria differ between the MRGCD, USGS, USACE, and USFWS managed stations. The following sub sections define these criteria, and include tables of the stations. Some tables may require use of the reader's zoom feature.

16.1 MRGCD Stream Flow Data

The MRGCD managed gage stations and USBR pumping station data sets are transmitted directly to the district office via radio telemetry just prior to the top of the hour and just prior to 30 minutes past each hour, and then automatically received into the ET Toolbox from the MRGCD office via FTP.

The MRGCD uses the Standard Hydrometeorological Exchange Format (SHEF) convention, with a three character gage name followed by DV (diversion), CN (canal), DR (drain), and WW (waste way). An example MRGCD gage is CORCN (Corrales Main Canal). There are also other miscellaneous 2-character codes.

Some data are missing because they were not provided by the district or the gages are not yet installed. The parameter (P) codes that are reported are:

QR = discharge in cfs, HG = height or stage in feet, HP = reservoir elevation in feet, LS = reservoir storage in acre-feet. A dash (-) as the 1st parameter defaults to QR, and a dash (-) as the 2nd parameter defaults to HG.

ID	P1	P2	Name	Description
240CN	QR	HP	240 FEEDER CANAL	SUPPLY TO 240 FEEDER FROM BELEN HIGH LINE CANAL
240WW	QR	HP	240 FEEDER WASTEWAY	RETURN FLOW FROM BELEN HIGH LINE/ISLETA DRAIN TO RIO GRANDE AT ISLETA PUEBLO
65001	-	-	650 FEEDER GATE#1	FLOW FROM ATRISCO FEEDER TO ATRISCO FEEDER AT 650 FEEDER CANAL
65002	-	-	650 FEEDER GATE#2	FLOW FROM ATRISCO FEEDER TO ALBUQUERQUE MAIN CANAL AT 650 FEEDER CANAL
9MILE	QR	-		
ABQ10	QR	HP	ALBUQUERQUE MAIN CHECK #10	FLOW IN ALBUQUERQUE MAIN CANAL BELOW CHAMISAL LATERAL
ACHCN	-	-		
ALACN	-	-	ALAMEDA LATERAL HEADING	SUPPLY TO ALAMEDA LATERAL FROM ALBUQUERQUE MAIN CANAL
ALAWQ	WQ	WQ	RIO GRANDE AT ALAMEDA BRIDGE	WATER QUALITY
ALBCN	QR	HG	ALBUQUERQUE MAIN CANAL	SUPPLY AT HEADING OF ALBUQUERQUE MAIN CANAL
ALBDR	QR	HG	ALBUQUERQUE DRAIN	FLOW IN ALBUQUERQUE DRAIN AT TINGLEY BEACH
ALGCN	QR	HP	ALGODONES ACEQUIA	SUPPLY AT HEADING OF ALGODONES ACEQUIA
ALGDR	QR	HG	ALGODONES DRAIN	DIRECT DRAIN RETURN FROM COCHITI DIVISION TO ALBUQUERQUE DIVISION CANALS
ALJWW	QR	HP	ALEJANDRO WASTEWAY	RETURN FLOW FROM ISLETA DRAIN TO RIO GRANDE AT ISLETA PUEBLO
ALOCN	-	HP	ALAMILLO LATERAL	HEADING OF ALAMILLO LATERAL
ANGCN	QR	HG	ANGOSTURA LATERAL	SUPPLY AT HEADING OF ANGOSTURA LATERAL
ANGDV	QR	-	ANGOSTURA DIVERSION	TOTAL MRGCD DIVERSION FROM RIO GRANDE AT ANGOSTURA WEIR
ARE04	QR	HP	ARENAL MAIN CANAL CHECK #4	FLOW IN ARENAL MAIN CANAL BELOW PAJARITO LATERAL
ARE05	QR	HP	ARENAL MAIN CANAL CHECK #5	FLOW IN ARENAL MAIN CANAL BELOW GUN CLUB LATERAL
ARE08	QR	HP	ARENAL MAIN CANAL CHECK #8	FLOW IN ARENAL MAIN CANAL BELOW METZGER ROAD
ARECN	QR	HG	ARENAL MAIN CANAL HEADING	SUPPLY TO ARENAL MAIN CANAL FROM ATRISCO SIPHON
ARMCN	QR	HG	ARMIJO LATERAL HEADING	SUPPLY TO ARMIJO LATERAL FROM ATRISCO SIPHON
ARMWW	-	-	ARMIJO WASTEWAY	RETURN FLOW FROM ARMIJO LATERAL TO ATRISCO DRAIN (TO SUPPLY LOS PADILLAS HEADING)
ARS02	QR	HP	ALBUQUERQUE DRAIN CHECK #2	FLOW IN ALBUQUERQUE DRAIN BELOW BARR MAIN
ARSDR	QR	HG	ALBUQUERQUE DRAIN OUTFALL	RETURN FLOW FROM ALBUQUERQUE DRAIN TO RIO GRANDE AT ISLETA LAKES
ARYCN	-	-		
ATDCN	QR	HG	ATRISCO ACEQUIA	SUPPLY TO ATRISCO ACEQUIA FROM ATRISCO SIPHON
ATFCN	QR	HG	ATRISCO FEEDER CANAL	SUPPLY TO ATRISCO FEEDER CANAL FOR SOUTH VALLEY/ISLETA WEST SIDE
ATFWW	-	-	ATRISCO FEEDER WASTEWAY	RETURN FLOW TO ATRISCO FEEDER FROM ALBUQUERQUE MAIN CANAL AT STATION 912
ATRDR	QR	HG	ATRISCO DRAIN OUTFALL	RETURN FLOW FROM ATRISCO DRAIN TO RIO GRANDE AT ISLETA LAKES
ATSCN	QR	-	ATRISCO SIPHON	SUPPLY TO SOUTH VALLEY FROM ATRISCO FEEDER
AUGCN	QR	HP	AUGUSTINE LATERAL	SUPPLY TO AUGUSTINE LATERAL
BACCN	-	-	BACA LATERAL	SUPPLY TO BACA LATERAL
BACWW	-	-	BACA WASTEWAY	RETURN FLOW FROM BACA LATERAL TO COCHITI MAIN
BARCN	QR	HP	BARR MAIN HEADING	SUPPLY TO BARR MAIN FROM ALBUQUERQUE DRAIN
BELCN	QR	HP	BELEN HIGH LINE CANAL HEADING	DIVERSION TO WEST SIDE OF BELEN DIVISION FROM RIO GRANDE AT ISLETA WEIR
BELDR	QR	HG	BELEN DRAIN	RETURN FLOW FROM BELEN DRAIN TO RIO GRANDE
BERCN	QR	HG	BERNALILLO ACEQUIA HEADING	SUPPLY TO BERNALILLO ACEQUIA FROM PUMPING STATION
BESDV	-	-	BELEN EAST SIDE DIVERSION	DIVERSION TO EAST SIDE OF BELEN DIVISION FROM RIO GRANDE AT ISLETA WEIR
BHL02	QR	HG	BELEN HIGH LINE CANAL BELOW TEBO FEEDER	
BHLCN	QR	HP	BELEN HIGH LINE CANAL BELOW 240 FEEDER	
BRNWW	QR	HG	BROWN ARROYO WASTEWAY	RETURN FLOW FROM LUIS LOPEZ DITCH TO RIO GRANDE VIA BROWN ARROYO
BSMCN	-	-		
BSQDR	-	-		
BUTCN	QR	HG	BUTTE LATERAL AT ISLETA PUEBLO	FLOW IN BUTTE LATERAL AT N BOUNDARY OF ISLETA PUEBLO

ID	P1	P2	Name	Description
CACCN	-	-		
CENWW	QR	HP	CENTRAL AVENUE WASTEWAY	RETURN FLOW FROM ATRISCO FEEDER TO RIO GRANDE ABOVE CENTRAL AVENUE
CFR01	-	-	CORRALES FEEDER HEADING	SUPPLY TO CORRALES FEEDER FROM ALBUQUERQUE MAIN CANAL
CFR02	-	-	CORRALES FEEDER CHECK #2	FLOW IN CORRALES FEEDER THROUGH CHECK #2
CHACN	-	-		
CHI07	-	-		
CHICN	-	-		
CHMCN	QR	HG	CHAMISAL LATERAL	SUPPLY TO CHAMISAL LATERAL FROM ALBUQUERQUE MAIN CANAL
COC01	QR	HP	COCHITI MAIN CANAL CHECK #1	FLOW AND POOL HEIGHT AT 1 ST CHECK ON COCHITI MAIN CANAL
COC02	QR	HP	COCHITI MAIN CANAL CHECK #2	FLOW AND POOL HEIGHT AT 2 ND CHECK ON COCHITI MAIN CANAL
COC03	QR	HP	COCHITI MAIN CANAL CHECK #3	FLOW AND POOL HEIGHT AT 3 RD CHECK ON COCHITI MAIN CANAL
COC04	QR	HP	COCHITI MAIN CANAL CHECK #4	FLOW IN COCHITI MAIN BELOW BACA LATERAL HEADING
COC06	QR	HP	COCHITI MAIN CANAL CHECK #6	FLOW AND POOL HEIGHT AT 6 TH CHECK ON COCHITI MAIN CANAL
COC08	QR	HP	COCHITI MAIN CANAL CHECK #8	FLOW IN COCHITI MAIN ENTERING SANTO DOMIGO
COC09	QR	HP	COCHITI MAIN CANAL CHECK #9	FLOW IN COCHITI MAIN BELOW AUGUSTINE LATERAL HEADING
COCCN	QR	HG	COCHITI MAIN CANAL HEADING	SUPPLY TO COCHITI MAIN CANAL
COCDV	QR	-	COCHITI DIVERSION	TOTAL MRGCD DIVERSION FROM RIO GRANDE BELOW COCHITI RESERVOIR
COCWQ	WQ	WQ	RIO GRANDE BELOW COCHITI DAM	WATER QUALITY
CORCN	QR	HG	CORRALES MAIN CANAL	FLOW IN CORRALES MAIN CANAL AT WEST END OF SIPHON
CORWW	QR	HG	CORRALES WASTEWAY	RETURN FLOW FROM CORRALES MAIN CANAL TO RIO GRANDE AT LA ORILLA (END OF CORRALES MAIN)
COSCN	QR	HG		
DURCN	QR	HG	DURANES ACEQUIA HEADING	SUPPLY TO CHAMISAL LATERAL FROM GRIEGOS LATERAL
ELMDR	QR	HG	ELMENDORF DRAIN AT BDA	DELIVERY TO BOSQUE DEL APACHE FROM ELMENDORF DRAIN
ESCWW	QR	-		
FCRPS	QR	HG	FORT CRAIG PUMP STATION	PUMPED FLOW FROM LFCC TO RIO GRANDE FOR RGSM
FD302	-	-		
FD3GT	-	-		
FD3WW	QR	HG	FEEDER 3 WASTEWAY	RETURN FLOW FROM BELEN HIGH LINE TO RIO GRANDE NORTH OF HWY 346 BRIDGE
FLACN	-	-	FLORIDA LATERAL	HEADING OF FLORIDA LATERAL
GABCN	-	-	GABALDON LATERAL HEADING	SUPPLY TO GABALDON LATERAL AT HEADING
GARCN	-	-		
GR1CN	QR	HP	GRANT #1 LATERAL	SUPPLY TO HEADING OF BELEN GRANT #1
GRGGT	QR	HP	GRIEGOS LATERAL HEADING	SUPPLY TO GRIEGOS LATERAL FROM ALBUQUERQUE MAIN CANAL
GUNCN	QR	HP	GUN CLUB LATERAL HEADING	SUPPLY TO GUN CLUB LATERAL FROM ARENAL MAIN CANAL
HAYWW	QR	HG	HAYNES WASTEWAY	RETURN FLOW FROM CORRALES MAIN CANAL TO RIO GRANDE AT CALABACILLAS ARROYO
HELCN	-	-		
HELWW	-	-		
INDCN	QR	HG	INDIAN LATERAL	FLOW IN INDIAN LATERAL AT N BOUNDARY OF ISLETA PUEBLO
ISCAT	-	-	ATRISCO HABITAT	WATER SURFACE ELEVATION, INLET GAGE POSITION, CONTROL STATUS, CONTROL POWER
ISLDR	QR	HG	ISLETA DRAIN OUTFALL	RETURN FLOW FROM SOUTH VALLEY TO BELEN DIVISION OR RIO GRANDE
ISLDV	QR	-	ISLETA DIVERSION	TOTAL MRGCD DIVERSION FROM RIO GRANDE AT ISLETA WEIR
ISLWQ	WQ	WQ	ISLETA DAM	WATER QUALITY
JARCN	QR	HP	JARAL LATERAL	HEADING OF JARAL LATERAL
JRLCN	-	-		

ID	P1	P2	Name	Description
LCRDR	QR	HG	LOWER CORRALES DRAIN	RETURN FLOW FROM LOWER CORRALES DRAIN/SUMMERFORD LATERAL TO RIO GRANDE BELOW MONTANO BRIDGE
LCZCN	-	-		
LCZWW	QR	HG	LOS CHAVEZ WASTEWAY	RETURN FLOW TO RIO GRANDE FROM UPPER BELEN DRAIN
LEM02	-	-	LEMITAR RETURN	RETURN FLOW FROM LEMITAR LATERAL TO SOCORRO MAIN CANAL NORTH
LEMCK	-	-	LEMITAR CHECK (LFCC)	FLOW FROM LFCC TO MRGCD FOR USE BY SOCORRO MAIN
LEMCN	QR	HP	LEMITAR LATERAL	HEADING OF LEMITAR LATERAL
LEMDV	QR	-		
LEMWW	QR	HP	LEMITAR WASTEWAY	RETURN FLOW FROM SOCORRO MAIN NORTH INTO LFCC
LJYCN	QR	HG	LA JOYA ACEQUIA	SUPPLY TO LA JOYA ACEQUIA ASSOCIATION (NON-MRGCD)
LLSCN	-	-		
LLZCN	QR	HP	LUIS LOPEZ LATERAL	HEADING OF LUIS LOPEZ LATERAL
LMWCN	QR	HP	LEMITAR WASTE LATERAL	FLOW IN INDIAN LATERAL AT N BOUNDARY OF ISLETA PUEBLO
LNTCN	QR	HG	LAS NUTRIAS LATERAL	SUPPLY TO LAS NUTRIAS LATERAL
LOBC2	QR	HG	RIO GRANDE NEAR LOBATAS, CO	
LP1DR	QR	HP	LOWER PERALTA DRAIN OUTFALL	#RETURN FLOW FROM UPPER PERALTA DRAIN TO RIO GRANDE AT BELEN BRIDGE
LP2DR	QR	HP	LOWER PERALTA DRAIN OUTFALL	#RETURN FLOW FROM UPPER PERALTA DRAIN TO RIO GRANDE SOUTH OF BELEN BRIDGE
LSJDR	QR	HG	LOWER SAN JUAN DRAIN OUTFALL	RETURN FLOW FROM LOWER SAN JUAN DRAIN TO RIO GRANDE SOUTH OF HWY 60 BRIDGE
MOSCN	-	-	MOSLEY LATERAL	HEADING OF MOSLEY LATERAL
MRGCD	QR	-	MRGCD DEMAND AT COCHITI	TOTAL MRGCD "'DEMAND", VALUE CALCULATED TO MEET ALL AGRICULTURAL DIVERSIONS AND RIVER CARRIAGE LOSSES BETWEEN COCHITI AND SAN ACACIA
MTOGT	QR	HP	MONTANO WASTEWAY	RETURN FLOW FROM GRIEGOS LATERAL TO ATRISCO FEEDER
NBA04	-	-	BELEN CHECK #4	
NBA10	QR	HG	NEW BELEN DROP	FLOW TO DROP STRUCTURE AT END OF NEW BELEN ACEQUIA
NBACN	-	-	NEW BELEN ACEQUIA	SUPPLY TO NEW BELEN ACEQUIA AT HEADING
NBAWW	-	-		
NBLWW	-	-	NEW BELEN WASTEWAY	RETURN FLOW FOM NEW BELEN ACEQUIA TO RIO GRANDE SOUTH OF BNSF BRIDGE
NBYPS	QR	HG	NORTH BOUNDARY PUMP STATION	PUMPED FLOW FROM LFCC TO RIO GRANDE FOR RGSM
NCPCK	-	-	NEIL CUPP CHECK (LFCC)	FLOW FROM LFCC TO MRCGD SOCORRO MAIN
NCPDV	QR	-		
NCPPS	QR	HG	NEIL CUPP PUMP STATION	PUMPED FLOW FROM LFCC TO RIO GRANDE FOR RGSM
NM111	QR	-	LANGEMANN OUTFLOW	
NM122	QR	-	LOW FLOW SOUTH INFLOW	
NM133	QR	-	RIVERSIDE CANAL	
NM144	QR	-	SOCORRO TAILWATER INFLOW	
NM155	QR	-	SOUTHERN WETLANDS OUTFLOW	
OJSCN	QR	HG	OLD JARALES HEADING	HEADING OF OLD JARALES DITCH AT FLUME
OTO21	-	-		
OTOCN	-	-		
PAJCN	QR	HP	PAJARITO LATERAL HEADING	SUPPLY TO PAJARITO LATERAL FROM ARENAL MAIN CANAL
PAJWW	QR	HP	PAJARITO WASTWAY	RETURN FLOW FROM PAJARITO/ARMIJO LATERALS TO ATRISCO DRAIN (TO SUPPLY LOS PADIILLAS HEADING)
PERCN	-	-		
PERWW	QR	HG	PERALTA WASTEWAY	RETURN FLOW FROM PERALTA MAIN CANAL TO RIO GRANDE NORTH OF BELEN BRIDGE
PMC04	-	-		
PMC08	QR	HP	PERALTA MAIN CANAL CHECK #8	FLOW IN PERALTA MAIN CANAL BELOW VALENCIA HEADING
PMC11	QR	HP	PERALTA MAIN CANAL CHECK #11	FLOW IN PERALTA MAIN CANAL BELOW MOYA HEADING
PMC13	-	-		
PMC21	-	-		
POLCN	QR	HP	POLVADERA LATERAL	HEADING OF POLVADERA LATERAL
PRDCN	-	-		

ID	P1	P2	Name	Description
RGSMF	-	-		
SABCN	-	-		
SABDR	QR	HG	SABINAL DRAIN OUTFALL	RETURN FLOW FROM SABINAL DRAIN TO RIO GRANDE NORTH OF HWY 60
SABWQ	WQ	WQ	SABINAL DRAIN OUTFALL	WATER QUALITY
SADCN	QR	HG	SAN ANTONIO LATERAL AT BDA	DELIVERY TO BOSQUE DEL APACHE FROM SAN ANTONIO LATERA
SADGT	QR	HP	SAN ANTONIO LATERAL	HEADING OF SAN ANTONIO LATERAL
SAFCN	QR	HG	SANTA ANA FEEDER CANAL	SUPPLY TO SANTA ANA DITCH HEADING, SAN FELIPE LANDS, SPILL TO DRAIN
SANCN	QR	HP	SANDIA ACEQUIA HEADING	SUPPLY TO SANDIA ACEQUIA FROM ALBUQUERQUE MAIN CANAL
SANWW	QR	HP	SANDIA LAKES WASTEWAY	RETURN FLOW FROM ATRISCO FEEDER TO RIO GRANDE AT SANDIA LAKES
SBYPS	QR	HG	SOUTH BOUNDARY PUMP STATION	PUMPED FLOW FROM LFCC TO RIO GRANDE FOR RGSM
SCZCN	QR	HP	SANCHEZ FEEDER	
SFRDR	QR	HG	SAN FRANCISCO DRAIN OUTFALL	RETURN FLOW FROM SAN FRANCISCO DRAIN TO RIO GRANDE (VIA RIO PUERCO) SOUTH OF HWY 60
SFWDR	QR	HG	SAN FELIPE WEST DRAIN OUTFALL	SAN FELIPE DITCH AND SAN FELIPE WEST DRAIN OUTFALL TO RIO GRANDE 60
SILCN	QR	HG	SILE MAIN CANAL HEADING	SUPPLY TO SILI MAIN CANAL
SILWW	QR	HP	SILE MAIN WASTEWAY	RETURN FLOW FROM SILI MAIN CANAL TO RIO GRANDE
SJM02	QR	HP	SAN JUAN MAIN CANAL CHECK #2	FLOW IN SAN JUAN MAIN CANAL BELOW SAIZ HEADING
SJM05	QR	HP	SAN JUAN MAIN CANAL CHECK #5	FLOW IN SAN JUAN MAIN CANAL BELOW LAS NUTRIAS HEADING
SJM12	QR	HP	SAN JUAN MAIN CANAL CHECK #12	FLOW IN SAN JUAN MAIN CANAL BELOW GRANT #1 HEADING
SJM15	-	-	SAN JUAN MAIN CANAL CHECK #15	FLOW IN SAN JUAN MAIN CANAL BELOW LAS NUTRIAS RETURN FLOW
SJMCN	QR	HG	SAN JUAN MAIN CANAL HEADING	SUPPLY TO SAN JUAN MAIN CANAL
SLNGT	QR	HP	SLOAN'S GATE	HEADING OF SAUSAL/LOS CHAVEZ DITCHES
SMC10	QR	HP	SOCORRO CHECK 10	FLOW FROM SOCORRO MAIN NORTH TO SOCORRO MAIN CENTER
SMSCN	QR	HG	SOCORRO MAIN SOUTH AT BDA	DELIVERY TO BOSQUE DEL APACHE FROM SOCORRO MAIN SOUTH
SNA01	QR	HP	SAN ACACIA GATE 1	FLOW THROUGH LANGEMANN GATE TO RIVER DOWNSTREAM OF SAN ACACIA WEIR, RGSM BYPASS
SNA02	QR	HP	SAN ACACIA GATE 2	FLOW THROUGH LANGEMANN GATE INTO SOCORRO MAIN CANAL, MRGCD DIVERSION AT SAN ACACIA
SNA03	-	-	RIVER GATE (S), SAN ACACIA DAM	FLOW THROUGH SAN ACACIA DAM IN EXCESS OF RGSM GATE
SNADV	QR	-	SAN ACACIA DIVERSION	TOTAL ACTUAL DIVERSION FROM RIO GRANDE BY SAN ACACIA DAM
SNAWW	QR	-		
SNAWQ	WQ	WQ	SAN ACACIA	WATER QUALITY
SOACN	QR	HP	SOCORRO ACEQUIA	HEADING OF SOCORRO ACEQUIA
SOCCK	-	-	SOCORRO CHECK (LFCC)	FLOW FROM LFCC TO MRGCD FOR USE BY SOCORRO MAIN
SOCCN	QR	HG	SOCORRO MAIN CANAL	FLOW IN SOCORRO MAIN CANAL NORTH, SUPPLY TO SOCORRO DIVISION
SOCDR	QR	HG	SOCORRO DRAIN AT BDA	DELIVERY TO BOSQUE DEL APACHE FROM SOCORRO DRAIN
SOCDV	QR	-		
SOCWW	QR	HG	SOCORRO WASTEWAY	RETURN FLOW FROM SOCORRO MAIN TO LFCC
SQBCN	QR	HG	SQUARE BOWL FEEDER CANAL	SUPPLY TO SQUARE BOWL FEEDER CANAL
STYWW	QR	HG	STOREY WASTEWAY	RETURN FLOW FROM SAN JUAN CANAL TO RIO GRANDE SOUTH OF HWY 346 BRIDGE
TEBGT	QR	HP	TEBO FEEDER CANAL	DIVERSION FROM BELEN HIGHLINE TO END OF NEW BELEN ACEQUIA
TOMCN	-	-		
UBLDR	QR	HP	UPPER BELEN DRAIN	FLOW IN BELEN DRAIN BELOW OLD JARALES HEADING
UBLGT	QR	HP	UPPER BELEN DRAIN GATE	FLOW FROM 240 FEEDER TO HEADING OF BELEN DRAIN SYSTEM
UCRDR	QR	HG	UPPER CORRALES DRAIN	RETURN FLOW FROM UPPER CORRALES DRAIN TO RIO GRANDE AT ALAMEDA BRIDGE
UN7DR	QR	HG	UNIT 7 DRAIN	FLOW IN UNIT 7 DRAIN ARRIVING AT SAN ACACIA DAM
UN7WW	QR	-	UNIT 7 WASTEWAY	UNIT 7 DRAIN FLOW RETURNED TO RIO GRANDE ABOVE SAN ACACIA DAM

ID	P1	P2	Name	Description
VALCN	-	-		
VAZCN	-	-	VAZQUEZ LATERAL	HEADING OF VAZQUEZ LATERAL
WUADV	-	-	WATER UTILITY AUTHORITY DIVERSION	ABCWUA DIVERSION FROM RIO GRANDE N OF PASEO AVE.
WUATF	-	-	WATER UTILITY AUTHORITY These are Atrisco RSGM seperations.	ABCWUA TREATMENT PLANT DISCHARGE TO RIO GRANDE S OF RIO BRAVO BLVD.
ELEVA	-	-	ATRISCO HABITAT	WATER SURFACE ELEVATION
GATEA	-	-	ATRISCO HABITAT	INLET GAGE POSITION
CONTA	-	-	ATRISCO HABITAT	CONTROL STATUS
POWEA	-	-	ATRISCO HABITAT	CONTROL POWER

16.2 USBR Pumping Stations

Pumping station data are sets are are received by the MRGCD from the USBR just prior to the top of the hour and just prior to 30 minutes past each hour. Similar to MRGCD data, these data are in the Standard Hydrometeorological Exchange Format (SHEF) convention.

These data, which are managed by the USBR, use a three character gage name followed by PS (pumping station). An example pumping station is NCPPS.

The parameter (P) codes that are reported are: QR = discharge in cfs, HG = height or stage in feet.

ID	P1	P2	Name	Description
FCRPS	QR	HG	FORT CRAIG PUMP STATION	PUMPED FLOW FROM LFCC TO RIO GRANDE FOR RGSM
NBYPS	QR	HG	NORTH BOUNDARY PUMP STATION	PUMPED FLOW FROM LFCC TO RIO GRANDE FOR RGSM
NCPPS	QR	HG	NEIL CUPP PUMP STATION	PUMPED FLOW FROM LFCC TO RIO GRANDE FOR RGSM
SBYPS	QR	HG	SOUTH BOUNDARY PUMP STATION	PUMPED FLOW FROM LFCC TO RIO GRANDE FOR RGSM
TOTPS			Total NCPPS NBYPS SBYPS FCRPS	NCPPS+NBYPS+SBYPS+FCRPS

The pumping station file named TOTPS (total pumping station) provides the combined daily values of the four stations, a combined daily average, a total-to-date for each station in ac-ft, and a total-to-date of all four stations in ac-ft. These data are available from the New Mexico menu (figure 3 W), choosing Pumping Station Data under Historic Data. Click on the current year and then TOTPS.gage, figure 43. W).

16.3 USGS Stream Flow Data

The data are automatically received into the ET Toolbox from the USGS via World Wide Web get (Wget).

The USGS uses the Standard Hydrometeorological Exchange Format (SHEF) convention. This is a three character gage name followed by the 1st character of the state name, followed by a number representing the state's alphabetical order. New Mexico (N) is the 5th state (5). Therefore all USGS gages in New Mexico are identified by N5 in the 4th and 5th character positions. An example USGS gage is OTWN5.

The parameter (P) codes that are reported are: QR = discharge in cfs, HG = height or stage in feet.

ID	P1	P2	Name	Description
ABQN5	QR	HG	RIO GRANDE AT ALBUQUERQUE	FLOW IN RIO GRANDE AT CENTRAL AVE. IN ALBUQUERQUE (08330000)
AICN5	QR	HG	RIO CHAMA BLW ABIQUIU DAM	(08287000)
BELN5	QR	HG	RIO GRANDE AT HWY 346 NEAR BOSQUE, NM	(08331510)
BNDN5	QR	HG	RIO PUERCO AT BERNARDO	(08353000)
BRGN5	QR	HG	RIO GRANDE NEAR BOSQUE FARMS	FLOW IN RIO GRANDE NEAR BOSQUE FARMS, NM (08331160)
CCCN5	QR	HG	R.G. BLW COCHITI, SILE, COCHITI CANAL	(08313500)
CTDN5	QR	HG	RIO GRANDE BELOW COCHITI DAM	FLOW IN RIO GRANDE BELOW COCHITI, DOES NOT INCLUDE FLOW TO COCHITI DIVISION CANALS (08317400)
EDBN5	QR	HG	RIO GRANDE BELOW ELEPHANT BUTTE DAM	(08361000)
EMBN5	QR	HG	RIO GRANDE AT EMBUDO	(08279500)
ISLN5	QR	HG	RIO GRANDE AT ISLETA LAKES	FLOW IN RIO GRANDE AT ISLETA LAKES (08330875)
JECN5	QR	HG	RIO JEMEZ BELOW JEMEZ CANYON	FLOW IN RIO JEMEZ ENTERING RIO GRANDE JUST BELOW ANGOSTURA WEIR (083289500
OTWN5	QR	HG	RIO GRANDE AT OTOWI BRIDGE	FLOW IN RIO GRANDE AT OTOWI BRIDGE, NM (08313000)
RCAN5	QR	HG	RIO CHAMA ABV ABIQUIU DAM	08286500
RCEN5	QR	HG	RIO CHAMA BLW EL VADO	08285500
RGAN5	QR	HG	RIO GRANDE NEAR ALAMEDA	FLOW IN RIO GRANDE AT PASEO DEL NORTE BRIDGE, BELOW WUA DIVERSION (08329928)
RGBN5	QR	HG	RIO GRANDE AT ALAMEDA BRIDGE	FLOW IN RIO GRANDE AT ALAMEDA BRIDGE, ABOVE WUA DIVERSION (08329918)
RGCN5	QR	HG	GALISTEO CREEK BELOW GALISTEO	FLOW BEING RELEASED FROM GALISTEO RESERVOIR TO RIO GRANDE VIA GALISTEO ARROYO (08317950)
RGEN5	QR	HG	RIO GRANDE AT ESCONDIDA	FLOW IN RIO GRANDE AT ESCONDIDA BRIDGE (08355050)
RGQN5	QR	HG	RIO GRANDE NEAR BOSQUE, NM	FLOW IN RIO GRANDE AT HWY 346 BRIDGE (08331510)
RGSN5	QR	HG	RIO GRANDE AT SAN ANTONIO	FLOW IN RIO GRANDE AT SAN ANTONIO (US HWY 380 BRIDGE) (08355490)
RLPN5	QR	HG	RIO CHAMA NR LA PUENTE	(08284100)
SFPN5	QR	HG	RIO GRANDE AT SAN FELIPE PUEBLO	FLOW IN RIO GRANDE AT SAN FELIPE PUEBLO (08319000)
SILN5	QR	HG	R.G. BLW COCHITI, SILE, COCHITI CANAL	(08314000)
SMCN5	QR	HG	LFCC AT SAN MARCIAL	FLOW IN LOW FLOW CONVEYANCE CHANNEL AT SAN MARCIAL (08358300)
SMFN5	QR	HG	RIO GRANDE AT SAN MARCIAL	FLOW IN RIO GRANDE AT SAN MARCIAL (08358400)
SNAN5	QR	HG	RIO GRANDE AT SAN ACACIA	FLOW IN RIO GRANDE BELOW SAN ACACIA DAM (08354900)
WBHN5	QR	HG	LOWER WILLOW CREEK	BELOW HERON RESERVOIR (08284520)

16.4 USACE Stream Flow Data

The data are automatically received into the ET Toolbox from the USACE via World Wide Web get (Wget).

The USACE uses the Standard Hydrometeorological Exchange Format (SHEF) convention. This is a three character gage name followed by the 1st character of the state name, followed by a number representing the state's alphabetical order. New Mexico (N) is the 5th state (5). Therefore all USACE gages in New Mexico are identified by N5 in the 4th and 5th character positions. Colorado is C2. An example USACE gage is ABIN5.

The parameter (P) codes that are reported are: QR = discharge in cfs, HG = height or stage in feet, HP = reservoir elevation in feet, LS = reservoir storage in acre-feet.

ID	P1	P2	Name	Description
ABIN5	LS	HP	ABIQUIU RESERVOIR	
AVLN5	LS	HP	AVALON RESERVOIR	
CBLN5	LS	HP	BRANTLEY RESERVOIR	
COCN5	LS	HP	COCHITI LAKE	
EBDN5	LS	HP	ELEPHANT BUTTE RESERVOIR	
ELVN5	LS	HP	EL VADO DAM	
HEWN5	QR	HG	LOWER WILLOW CREEK	ABOVE HERON RESERVOIR
LOBC2	QR	HG	RIO GRANDE NEAR LOBATAS, CO	
TRAN5	LS	HP	HERON RESERVOIR	

16.5 USFWS (US Fish and Wildlife Service) Stream Flow Data

The data are automatically received into the ET Toolbox from the USFWS via World Wide Web get (Wget).

The USFWS uses the Standard Hydrometeorological Exchange Format (SHEF) convention. However, the naming convention begins with NM followed by a three digit number.

The parameter (P) codes that are reported are: QR = discharge in cfs

ID	P1	P2	Name
NM111	QR	-	LANGEMANN OUTFLOW
NM122	QR	-	LOW FLOW SOUTH INFLOW
NM133	QR	-	RIVERSIDE CANAL
NM144	QR	-	SOCORRO TAILWATER INFLOW
NM155	QR	-	SOUTHERN WETLANDS OUTFLOW

16.6 Schematics

All of the data are assembled into text files and plots; in some instances combining data for operations. There are four schematics within the MRGCD, each representing a water delivery division.

In addition, there is a schematic for the entire Rio Grande from the Otowi Bridge gage to the San Marcial gage, and a schematic for Middle Rio Grande/San Juan Chama Operations from the Lobatas gage to below Elephant Butte Dam.

Access to the schematics is via the New Mexico menu (figure 2 W) choosing one of the six schematics under Stream Flow Data:

Cochiti Division Schematic	(figure 44	W)
Albuquerque Division Schematic	(figure 45	W)
Belen Division Schematic	(figure 46	W)
Socorro Division Schematic	(figure 47	W)
Rio Grande Schematic	(figure 48	W)
MRG/SJC Operations Schematic	(figure 49	W)

Gray pop-up boxes near the top of each schematic allow easy access to other schematics and the New Mexico menu (ET Toolbox) and 24 Hour Rain (NEXRAD rain).

The following text is included after the schematic, where appropriate, for guidance:

> Middle Rio Grande Conservancy District (MRGCD) Gage Schematic
> Values in boxes are latest discharges in cfs, except reservoir storage in ac-ft.
> Click on green boxes for MRGCD gage plots.
> Click on yellow boxes for USGS gage plots.
> Click on orange boxes for RGSM (USBR) pumping station plots.
> Click on boxes for Reservoir Storage plots. Values are acre-feet.
> Click on mint green boxes for USFWS gage plots.
> Click on red boxes for reach summary plots.
> Click on pink circles, with ?, for information about the schematic, where available.

The schematics are updated every 30-minutes, as noted by the posted date and time at the bottom. All times are Mountain Standard Time (MST) throughout the year. The schematics show the inflows and outflows throughout the MRGCD.

NOTE: Downloading and use of MRGCD data is possible but discouraged due to the provisional status of the data. MRGCD may be contacted to provide final data, though this may require some time.

No value in a box means the stream flow gage network has not been established. Clicking on a box with a value, or N/A (Not Available), pops-up a graph containing two charts. This is an example of the Socorro Main Canal Heading (figure 50 W). The bottom chart shows the height (stage) of the gage in feet and the top shows the discharge (stream flow) in cfs. A table to the right of the graph provides the year-to-date gage information (figure 51).

Another example is the USGS reservoir storage gage at Cochiti Lake (figure 52 W). The bottom chart shows the water surface elevation above sea level in feet and the top shows the storage in acre-feet. A table to the right of the graph provides the year-to-date gage information (figure 53).

The MRG/SJC Operations schematic contains unique data not found in the others. In addition to USGS stream flow gages, it contains reservoir storage and reachs 1 through 8 inflows, depletions and gain/loss. Also shown are total MRGCD demands at Cochiti and diversions at key locations within the District. The following three tables show how the inflows, depletions, and gain/loss are determined.

This table defines how the inflows are determined, which are summations of daily average stream flows:

ID	P1	P2	Name	Description
R1INF	I1	-	REACH 1 INFLOW	CTDN5+RGCN5+AUGCN+SILWW
R2INF	I2	-	REACH 2 INFLOW	SFPN5+SQBCN+SANWW
R3INF	I3	-	REACH 3 INFLOW	RGBN5+UCRDR+HAYWW+CORWW+LCRDR+CENWW
R4INF	I4	-	REACH 4 INFLOW	ABQN5+WUATF+ATRDR+ARSDR
R5INF	I5	-	REACH 5 INFLOW	RGSMF+ALJWW+240WW+LCZWW+PERWW+LP1DR+BELDR+NBAWW+LP2DR
R6INF	I6	-	REACH 6 INFLOW	RGQN5+STYWW+FD3WW+SABDR+LSJDR+SFRDR+BNDN5
R7INF	I7	-	REACH 7 INFLOW	SNAN5+9MILE+NCPPS+NBYPS+SBYPS
R8INF	I8	-	REACH 8 INFLOW	SMFN5+FCRPS

This table defines how the depletions are determined, which are the total water uses, as calculated by the ET Toolbox, minus the NEXRAD rain. No ground water or other extractions are included:

ID	P1	P2	Name	Description
R1DEP	WU	PP	REACH 1 DEPLETION	TOTAL WATER USE (ET - RAIN) COCHITI TO SAN FELIPE
R2DEP	WU	PP	REACH 2 DEPLETION	TOTAL WATER USE (ET - RAIN) SAN FELIPE TO ALAMEDA
R3DEP	WU	PP	REACH 3 DEPLETION	TOTAL WATER USE (ET - RAIN) ALAMEDA TO CENTRAL AVENUE
R4DEP	WU	PP	REACH 4 DEPLETION	TOTAL WATER USE (ET - RAIN) CENTRAL AVENUE TO ISLETA
R5DEP	WU	PP	REACH 5 DEPLETION	TOTAL WATER USE (ET - RAIN) ISLETA TO RIO GRANDE NEAR BOSQUE, NM
R6DEP	WU	PP	REACH 6 DEPLETION	TOTAL WATER USE (ET - RAIN) RIO GRANDE NEAR BOSQUE, NM TO SAN ACACIA
R7DEP	WU	PP	REACH 7 DEPLETION	TOTAL WATER USE (ET - RAIN) SAN ACACIA TO SAN MARCIAL
R8DEP	WU	PP	REACH 8 DEPLETION	TOTAL WATER USE (ET - RAIN) SAN MARCIAL TO ELEPHANT BUTTE

This table defines how the gain/loss is determined, which are the inflows minus the depletions:

ID	P1	P2	Name	Description
R1GAL	GL	-	REACH 1 GAINLOSS	R1INF-R1DEP
R2GAL	GL	-	REACH 2 GAINLOSS	R2INF-R2DEP
R3GAL	GL	-	REACH 3 GAINLOSS	R3INF-R3DEP
R4GAL	GL	-	REACH 4 GAINLOSS	R4INF-R4DEP
R5GAL	GL	-	REACH 5 GAINLOSS	R5INF-R5DEP
R6GAL	GL	-	REACH 6 GAINLOSS	R6INF-R6DEP
R7GAL	GL	-	REACH 7 GAINLOSS	R7INF-R7DEP
R8GAL	GL	-	REACH 8 GAINLOSS	R8INF-R8DEP

16.7 Direct Links to USGS Gage Information

Clicking on the white triangles found on many of the pop-up windows throughout the AWARDS/ET Toolbox system provides real-time Internet links to USGS gage graphs and text data. This is an example available by clicking on the white triangle for Otowi Bridge in the Alcalde window of (figure 4 W) or from the Stream Flow Products image (figure 54) to get the Alcalde window containing the white triangle. (W). The address for this USGS gage is:

http://waterdata.usgs.gov/nm/nwis/uv/gen_stn_pg?station=08313000 (Rio Grande at Otowi Bridge).

17 Water Quality Data

A water quality component was added to the Toolbox in 2014. This is a schematic similar to those in (section 16), Stream Flow Data. More specifically, a modified MRG/SJC Operations schematic containing MRGCD, USGS, and USACE stream flow is used with added water quality data. This table includes the water quality stations received in conjunction with the MRGCD stream flow data, where the parameter (P) code is WQ. Other stations may be added in the future.

ID	P1	P2	Name	Description
ALAWQ	WQ	WQ	RIO GRANDE AT ALAMEDA BRIDGE	WATER QUALITY
COCWQ	WQ	WQ	RIO GRANDE BELOW COCHITI DAM	WATER QUALITY
ISLWQ	WQ	WQ	ISLETA DAM	WATER QUALITY
SABWQ	WQ	WQ	SABINAL DRAIN OUTFALL	WATER QUALITY
SNAWQ	WQ	WQ	SAN ACACIA	WATER QUALITY

Access to the resulting schematic is via the New Mexico menu (figure 2 W) choosing: Water Quality Schematic (figure 55) W).

NOTE: Downloading and use of MRGCD data is possible but discouraged due to the provisional status of the data. MRGCD may be contacted to provide final data, though this may require some time.

Like the stream flow schematics, the water quality schematic is updated every 30-minutes, as noted by the posted date and time at the bottom. All times are Mountain Standard Time (MST) throughout the year.

No value in a box means the water quality gage network has not been established. Clicking on a red circle with a value, or N/A (Not Available), pops-up a graph containing two charts. This is an example of the Sabinal Drain Outfall (figure 56) W). The top chart shows the water temperature in Deg. C and the dissolved oxygen (DO) in milligrams per liter. The bottom shows the salinity in millisiemens per centimeter. A table to the right of the graph provides the year-to-date data (figure 57). These data, depending on the gage and source, may contain:

Data	Description	Units
Temp.	Degrees	(Deg. C) and (Deg. F)
EC	Salinity	Millisiemens per Centimeter (ms/cm)
TDS	Total Dissolved Solids	Parts per Million (ppm)
DO	Dissolved Oxygen	Milligram per Liter (mg/l)
WH	Water Head above gage	feet (ft)
PH		
Turb.	Turbidity	Formazin Nephelometric Units (fnu)
DN	Dissolved Nitrate	Milligram per Liter (mg/l)
DP	Dissolved Phosphate	Milligram per Liter (mg/l)

18 Interface with RiverWare

ET Toolbox files for each of the eight river reaches are available for the URGWOM team to access at around 8:30 AM MST each day. The river reach boundaries are listed in the following table.

River Reach 1	Cochiti Dam gage to San Felipe gage
River Reach 2	San Felipe gage to Alameda gage
River Reach 3	Alameda gage to Central Avenue gage
River Reach 4	Central Avenue gage to Isleta gage
River Reach 5	Isleta gage to Bernardo gage (Hwy. 346)
River Reach 6	Bernardo gage to San Acacia gage
River Reach 7	San Acacia gage to San Marcial gage (includes the Bosque Del Apache)
River Reach 8	San Marcial gage to north end of Elephant Butte Reservoir

These ET Toolbox files contain daily consumptive use rate (inches/day) for all agricultural, riparian, and urban vegetation classifications. Refer to AWARDS/ET Toolbox Calculations (section 13) for more information.

A sample ET Toolbox file (for Reach 1 for a short period of time in June and July 2014 (figure 58) is shown here. It contains data, in inches/day, for each classification that is in the reach (the version available to the URGWOM team shows all data for the current year). The data for the last seven lines are forecast values based on the National Digital Forecast Database (NDFD) 5-km grid.

A sample ET Toolbox file for all reaches for a short period of time in June and July 2014 (figure 59) is shown here. It contains data, in cfs, for all classifications in each reach (the version available to the URGWOM team shows all data for the current year). The data for the last seven lines are forecast values based on the National Digital Forecast Database (NDFD) 5-km grid. Some quantities are negative because they are adjusted for rainfall,

These ET Toolbox files are not available from the website, therefore no web address is provided here. They are internal files processed in the computer system, and made available daily for use by the URGWOM team. The above two figures exist in this document only for information purposes - they are not intended to be accessed by the casual user of the ET Toolbox.

A file containing the classification keys and a file containing the acreage of each classification split between the east and west sides of the Rio Grande are also provided.

The tasks of developing the Data Management Interfaces (DMIs) between the ET Toolbox files, the Hydrologic Engineer Center - Data Storage System (HEC-DSS), and RiverWare were accomplished by the URGWOM team. Please contact the URGWOM team for information on how these provided data are used in the RiverWare Model. There address is: http://www.spa.usace.army.mil/Missions/CivilWorks/URGWOM.aspx (URGWOM).

19 Historic ET Toolbox Processing - 1975 to 2005

At the request of the URGWOM team, historic consumptive use values were processed to satisfy a requirement of determining agricultural and riparian water depletions in each of the river reaches. The results of this study were used to calibrate the URGWOM.

Years 1984 through 1998 were processed using a combination of the Alcalde and Los Lunas weather stations. Temperature and relative humidity from the Los Lunas station and solar radiation and wind from the Alcalde station were used to calculate the Penman Reference ET.

Years 1975 through 1983 were processed differently. For these years there were no data from Alcalde, and only temperature and precipitation data were available at Los Lunas. Therefore, a monthly comparison of temperature and precipitation was made with years 1984 through 2000. Daily relative humidity, solar radiation, and wind data from the closest matched month in the period 1984 through 2000 were then used to calculate the Penman Reference ET. An Excel spread sheet has been developed that shows the Los Lunas precipitation and temperature data, and a comparison of monthly precipitation and average temperatures for each year 1975 through 1983, with 1984 through 2000.

Access to the spread sheet is available through the Internet at:

http://www.usbr.gov/pmts/rivers/awards/Nm2/rg/NM_LosLunasCOOPdata.xls (W).

Page seven of the spread sheet contains documentation of the procedures used.

Years 1999 through the last most current year used temperature, relative humidity, solar radiation, and wind data from various weather stations for calculating the Penman Reference ET. The stations were assigned to specific 4 km x 4 km HRAP grid cells within each reach. Note that these are the original reaches in place before 2006:

1999	Reaches 1 and 2	Alcalde
	Reach 3	Rio Grande Nursery (NMCC)
	Reach 4	Los Lunas
	Reach 5	Boy's Ranch
	Reach 6	North Bosque
2000	Reach 1	Pena Blanca and Angostura
	Reach 2	Angostura
	Reach 3	Angostura, Rio Grande Nursery, and Albuquerque Golf Course (NMCC)
	Reach 4	Bosque Bar (MRGCD), Rio Grande Nursery, Los Lunas, Jarales, and Boy's Ranch
	Reach 5	Boy's Ranch
	Reach 6	Luis Lopez, North Bosque, and South Bosque
2001	Reach 1	Pena Blanca and Angostura
	Reach 2	Angostura
	Reach 3	Angostura, Rio Grande Nursery, and Albuquerque Golf Course (NMCC)
	Reach 4	Bosque Bar (MRGCD - through Dec 6), Rio Grande Nursery, Los Lunas, Jarales, and Boy's Ranch
	Reach 5	Boy's Ranch and San Acacia
	Reach 6	San Acacia, Luis Lopez, North Bosque, and South Bosque
2002	Reach 1	Pena Blanca and Angostura
	Reach 2	Angostura
	Reach 3	Angostura, Rio Grande Nursery, and Albuquerque Golf Course (NMCC)
	Reach 4	Rio Grande Nursery, Los Lunas, Jarales, and Boy's Ranch
	Reach 5	Boy's Ranch and San Acacia
	Reach 6	San Acacia, Luis Lopez, North Bosque, and South Bosque
	Reach 7	South Bosque
2003	Reach 1	Pena Blanca and Angostura
	Reach 2	Angostura
	Reach 3	Angostura and Candelaria Farms
	Reach 4	Candelaria Farms, Los Lunas, Jarales, and Boy's Ranch
	Reach 5	Boy's Ranch and San Acacia
	Reach 6	San Acacia, Luis Lopez, North Bosque, and South Bosque
	Reach 7	South Bosque

Additional MRGCD weather stations were added in 2004 and assigned to appropriate river reaches as data from them became available.

Occasionally data from weather stations were not available. In these cases interim substitutions were made while repairs were underway, or permanent replacements were made if new or nearby stations were available.

In all historic processing through 1998, only weather station precipitation data were used since NEXRAD data were not collected for the ET Toolbox until 1999. The historic data posted on the website for 1999 through the last most complete year uses NEXRAD precipitation. This is an important item to note when comparing 1975 through 1998 precipitation data with 1999 through current year precipitation data.

Numerous reruns of the historic ET Toolbox processing for 1975 through 1998 have occurred. The more recent was in February 2003 to correct problems with the agricultural acreage and precipitation in reach 6.

For these historic calculations, the vegetative acreage from the 1992/93 LUTA for reaches 1 through 5 were used, as well as the combinations of data sources for reach 6. Refer to GIS Land Classification (section 14).

The same crop coefficients and Penman Reference ET Equation were used. The only variance from year-to-year was the weather data.

The year 2001 ends on December 6 due to the Department of the Interior shutdown of Internet communications.

Additional historic processing was requested by the URGWOM team in 2006. This request was for processing years 2000 through 2005 using the new eight river reach delineations based on the 4km x 4km HRAP grid cells, not the 1-km QPE grid cells that started in 2007. It was also based on the newer IKONOS and Utah State University land classification. Refer to the New Mexico menu, (figure 2 W) Historic Data, ET Summary Information by New River Reaches (1-8), for the summaries and a listing of weather station assignments to the new reaches.

20 ET Toolbox Research

Future ET Toolbox research could include studies to:

1. Simplify overall Toolbox operation including NEXRAD data reduction and mapping.
2. Study and implement a rainfall/runoff model to better predict ungaged inflows to streams/river(s).
3. Modify ET for less than potential conditions.
4. Determine if adding soil moisture fields from Land Surface Models and observations, and soil types and slope, can be used in the ET Toolbox to improve the efficiency of water management.
5. Improve estimates of effective precipitation using soil types and slope, and soil moisture.
6. Improve the situation analysis matrix with predicted stream flow data.
7. Renew weather station network to ensure reliable weather data as required by the Standardized Reference ET method. Currently using the Hargreaves method.
8. Install additional weather stations in critical ET demand areas.
9. Provide weather station calibration and data quality resources to improve ET reliability.
10. Implement a field scheduling component based on real-time soil moisture monitoring, soil types, and plant growth, to improve irrigation delivery demands.
11. Access and use real-time ground water level information for integration into a system-wide water balance feature.
12. Improve the Stream Flow Schematics to include greater detail and missing data.
13. Improve the Web site, to make it more user friendly.

21 References

1. American Society of Agricultural Engineers (ASAE), 1983:
   Design And Operation Of Farm Irrigation Systems.
2. Jensen, M.E., 1998:
   Coefficients for Vegetative Evapotranspiration and Open Water Evaporation for the Lower Colorado River Accounting System. Report prepared for the U.S. Bureau of Reclamation, Boulder City, Nevada.
3. King, J.P., A.S. Bawazir, and T.W. Sammis, 2000:
   Evapotranspiration Crop Coefficients as a Function of Heat
   Units for Some Agricultural Crops in New Mexico. Technical Completion Report for Project No. 01-4-23955, New Mexico State University
4. Sammis, T.W., C.L. Mapel, D.G. Lugg, R.R. Lansford, J.T. McGuckin, 1985:
   Evapotranspiration Crop Coefficients
5. Predicted Using Growing Degree Days. Transactions of the ASAE (American Society of Agricultural Engineers) 28(3), pp. 773-780.
6. FAO Irrigation and Drainage Paper No. 56
7. Astronomical Almanac (1998)
8. IIHR Report No. 430, July 2003:
   Lake Evaporation Estimation In Arid Environments

9 Middle Rio Grande Conservancy District (MRGCD)

10. Colorado Agricultural Meteorological Network (COAGMET)
11. New Mexico State Climate Center (NMSCC)
12. National Severe Storm Laboratory (NSSL)
13. National Digital Forecast Database (NDFD)
14. National Centers for Environmental Prediction (NCEP)
15. FLO-2D
16. Upper Rio Grande Water Operations Model (URGWOM)
17. United States Geological Survey (USGS)
18. United States Army Corps of Engineers (USACE)
19. United States Fish and Wildlife Service (FWS)
20. Utah State University (USU)

22 FIGURES

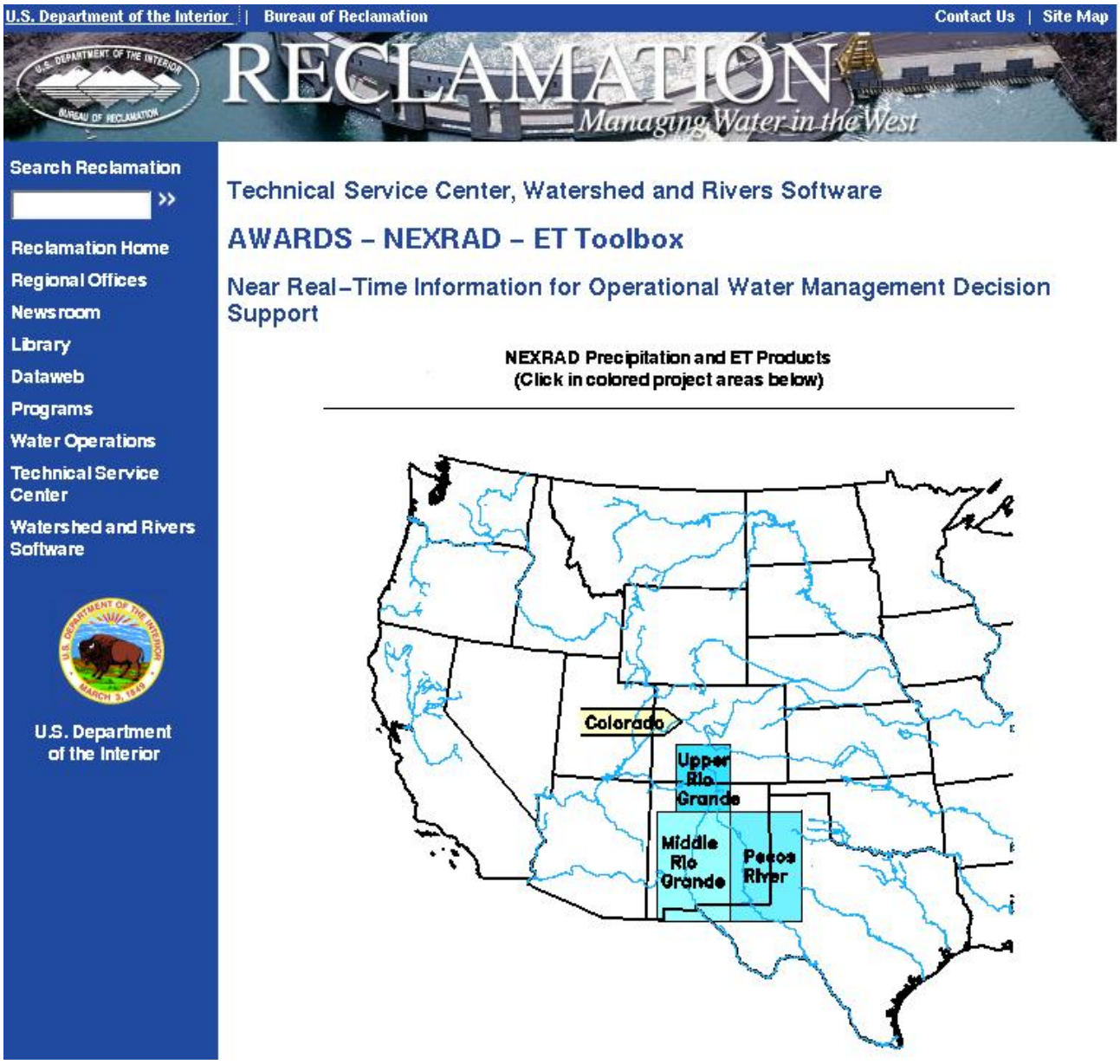


Figure 1: ET Toolbox Home Page

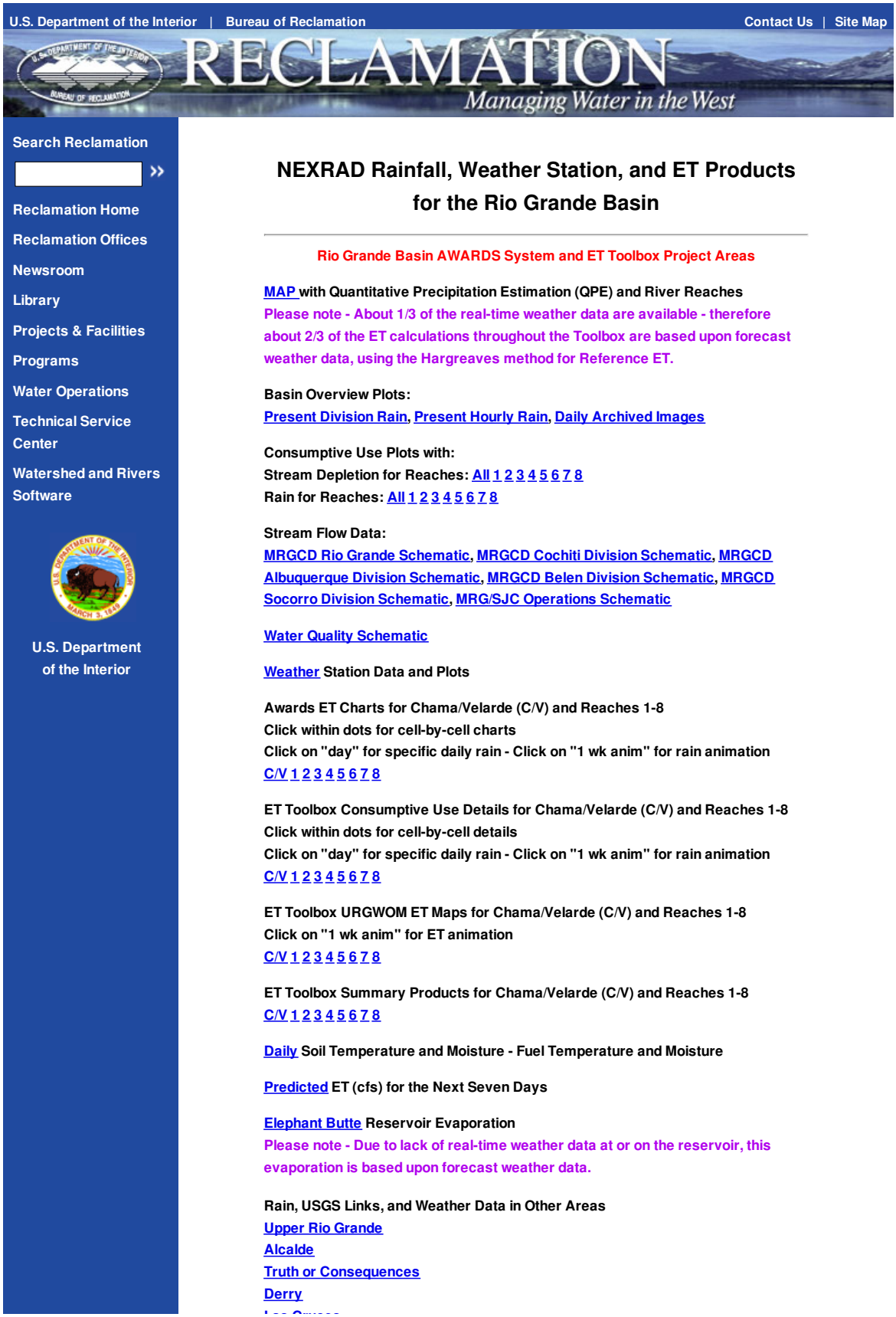


Figure 2: NEXRAD Rainfall, WX, and ET Products for the R. G. B. Menu - Part 1

Historic Data

1-hour Weather Data from MRGCD Operated Automated Weather Stations.

24-hour Weather Data from MRGCD Operated Automated Weather Stations and New Mexico State University Automated Weather Stations.

ET Summary Information by New River Reaches 1-8.

Gage Data from Middle Rio Grande Conservancy District (MRGCD), USGS, USACE, and FWS.

Pumping Station Data from USBR

Tamarisk ET Model and Comparisons

Archived Radar Precipitation Products (QPE)

1-Year of Archived Daily Upper Rio Grande QPESums Estimated Rainfall Images

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Links to Real-Time and Forecasted Weather Data

NCAR RAP Real-Time Weather Data (Satellite Loops etc.)

6-hour Animation loop of recent satellite west U.S. images -- GOES WEST IR from NOAA

6-hour Animation loop of recent satellite east U.S. images -- GOES EAST IR from NOAA

HPC National Quantitative Precipitation Forecast (QPF) Graphics
Day 1 Day 2 Day 3 Day 4-5

Medium Range Forecasts from the HPC:
Red = Max. Temperature, Blue = Min. Temperature, Green = Prob. of Precip.
Day 3 Max / Min Temp and PoP Forecasts
Day 4 Max / Min Temp and PoP Forecasts
Day 5 Max / Min Temp and PoP Forecasts
Day 6 Max / Min Temp and PoP Forecasts
Day 7 Max / Min Temp and PoP Forecasts

Current Monthly and Seasonal Climate Outlook from the CPC

Current U.S. Drought Monitor from the CPC

Related Links

- Current Atmospheric Soundings (Skew-T) for Albuquerque, NM (ABQ)
  and El Paso, TX (EPZ)

Figure 3: NEXRAD Rainfall, WX, and ET Products for the R, G, B, Menu - Part 2

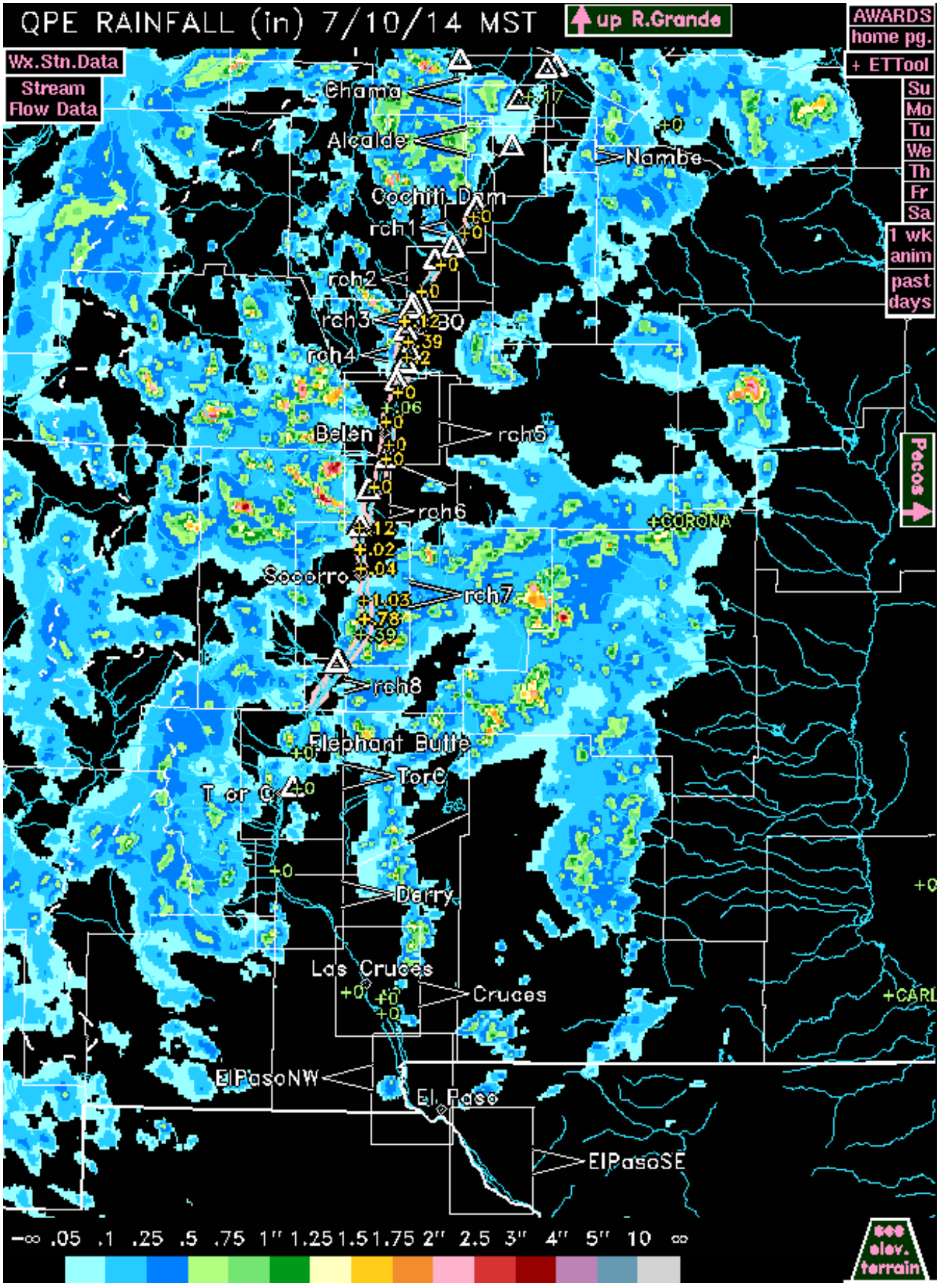

Figure 4: Rio Grande Map - Awards

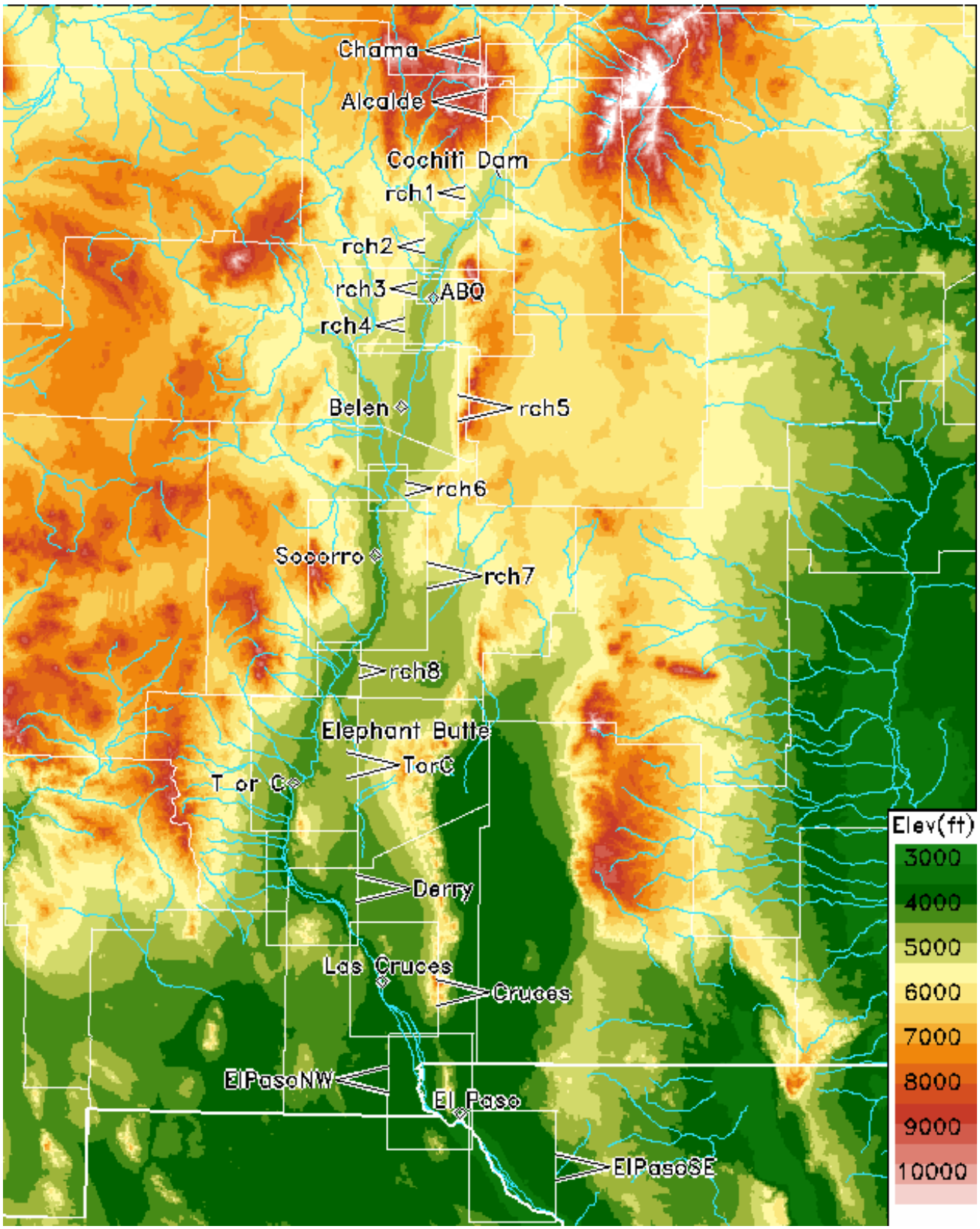

Figure 5: Colored Topography

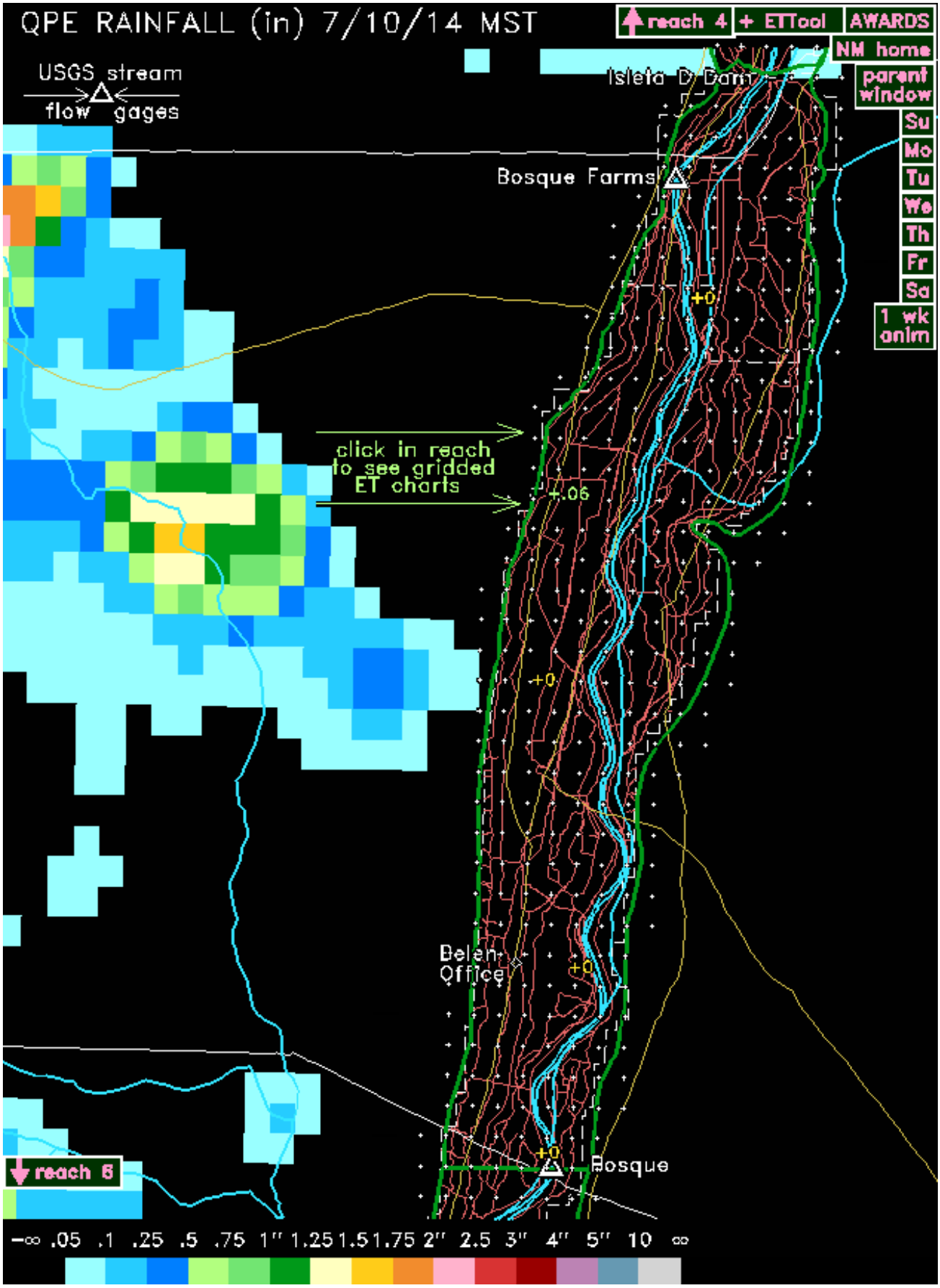

Figure 6: River Reach 5 - Awards

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Feb 06, 15 10:45 **BWWN.txt** Page 1/1

Bosque Farms − NM − Weather Data − 2014
Name: BWWN Source: mrgcd
Elev. 4856 ft
Lat. 34.832
Lon. 106.711

		July 4	July 5	July 6	July 7	July 8	July 9	July 10
Max. Temp.	(F)	90.0	91.0	96.0	93.0	92.0	93.0	95.0
Min. Temp.	(F)	61.0	63.0	63.0	60.0	60.0	64.0	61.0
Avg. Wind	(Mi/Hr)	1.4	1.4	1.0	0.6	2.3	2.1	1.3
Rel. Hum.	(%)	55.5	53.0	56.0	57.5	54.5	46.5	53.5
Rain	(In)	0.00	0.01	0.39	0.00	0.00	0.00	0.00
Solar Rad.	(Mj/Sq m)	27.30	22.90	26.60	29.70	26.70	26.40	24.90

Gage Monthly Total Rain:	
January	0.00
February	0.04
March	0.39
April	0.38
May	0.54
June	0.96
July	0.94

Alternate Data Key
ndfd == 5 km ndfd model
eta == 12 km eta model
[1−7] == forecast day
T == Temperature
W == Wind
H == Humidity
R == Rain
r == nexrad radar Rain
S == Solar Radiation
???? == weather station

Daily Weather Data and Reference ET

Month	Day	Max. Temp (F) |−−[T]−−|	Min. Temp (F)	Avg. Wind (Mi/Hr) [W]	Rel. Hum. (%) [H]	Rain (In) [Rr]	Solar Radiation (Mj/Sq m) [S]	Hargreaves Ref. ET (In)	Alternate Weather Data
July	10	95.0	61.0	1.3	53.5	0.00	24.90	0.29	
July	9	93.0	64.0	2.1	46.5	0.00	26.40	0.27	
July	8	92.0	60.0	2.3	54.5	0.00	26.70	0.27	
July	7	93.0	60.0	0.6	57.5	0.00	29.70	0.28	
July	6	96.0	63.0	1.0	56.0	0.39	26.60	0.29	
July	5	91.0	63.0	1.4	53.0	0.01	22.90	0.26	
July	4	90.0	61.0	1.4	55.5	0.00	27.30	0.26	
July	3	94.0	59.0	3.2	54.5	0.25	28.10	0.29	
July	2	92.0	59.0	2.5	53.0	0.06	27.00	0.28	
July	1	95.0	62.0	3.9	50.0	0.23	26.80	0.29	
June	30	101.0	56.0	1.8	44.0	0.00	24.60	0.33	
June	29	101.0	53.0	0.6	42.0	0.00	27.30	0.34	
June	28	98.0	61.0	1.3	39.5	0.00	29.10	0.31	
June	27	93.0	63.0	1.6	35.0	0.23	27.10	0.27	
June	26	99.0	54.0	1.4	41.5	0.00	27.50	0.33	
June	25	97.0	56.0	1.0	43.5	0.00	29.30	0.31	
June	24	98.0	52.0	1.0	42.0	0.00	28.40	0.32	
June	23	98.0	52.0	0.5	37.5	0.00	28.20	0.32	
June	22	96.0	54.0	1.1	39.0	0.00	27.20	0.31	
June	21	98.0	61.0	1.2	38.5	0.00	26.80	0.31	
June	20	95.0	53.0	1.9	35.5	0.15	29.20	0.31	
June	19	91.0	51.0	0.2	39.0	0.00	28.50	0.29	
June	18	90.0	51.0	1.0	47.5	0.00	23.90	0.28	
June	17	90.0	49.0	2.1	43.0	0.03	17.10	0.28	
June	16	92.0	50.0	2.7	35.5	0.20	25.80	0.29	
June	15	91.0	43.0	1.4	40.0	0.00	26.80	0.30	
June	14	93.0	52.0	3.5	45.5	0.00	29.00	0.30	
June	13	87.0	59.0	1.3	48.5	0.29	19.90	0.25	
June	12	94.0	53.0	1.1	37.5	0.00	28.60	0.30	
June	11	91.0	56.0	2.5	35.5	0.00	17.90	0.28	
June	10	93.0	45.0	1.3	40.0	0.00	28.70	0.30	
June	9	90.0	53.0	1.7	33.5	0.00	29.50	0.28	
June	8	92.0	57.0	2.0	41.0	0.00	27.10	0.28	
June	7	94.0	45.0	3.4	45.5	0.00	28.50	0.31	
June	6	97.0	51.0	1.0	43.5	0.00	29.20	0.32	
June	5	97.0	47.0	0.8	41.0	0.06	25.50	0.32	
June	4	100.0	52.0	1.1	39.5	0.00	28.50	0.33	
June	3	101.0	53.0	1.7	39.0	0.00	24.50	0.34	
June	2	98.0	49.0	0.6	39.0	0.00	29.40	0.32	
June	1	94.0	58.0	5.7	16.5	0.00	33.36	0.29	ndfd1TWHrS

Friday February 06, 2015 1/1

Figure 7: MRGCD Daily Weather Data

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Feb 06, 15 10:56 **REA5.BWWN.2330.1485.txt** Page 1/1

Bosque Farms – NM mrgcd
ESTIMATED CROP WATER USE – JUL 11, 2014

CROP	START DATE	DAILY CROP WATER USE–(IN) HARGREAVES ET – JUL 7	8	9	10	FORECAST HARGREAVES ET JUL 11	JUL 12	JUL 13	JUL 14	JUL 15	JUL 16	JUL 17	TERM DATE	SUM ET	7 DAY USE	14 DAY USE
FLO2DWater	101	0.33	0.32	0.32	0.34	0.34	0.32	0.32	0.34	0.33	0.33	0.32	1231	45.6	2.3	4.8
WetSands	101	0.33	0.32	0.32	0.34	0.34	0.32	0.32	0.34	0.33	0.33	0.32	1231	45.6	2.3	4.8
CotwBosque	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Cotw/SCW	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Cotw/ROW	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Cotw/SCROW	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
SaltCW	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
SaltC/ROW	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
RusOliveW	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Willow	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Shrubland	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Grassland	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Wetland	101	0.33	0.32	0.32	0.34	0.34	0.32	0.32	0.34	0.33	0.33	0.32	1231	45.6	2.3	4.8
SparceVeg	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Cottonwood	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
DTamarisk	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
STamarisk	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
GWillow	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Acacia/Bus	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
Wetland2	101	0.33	0.32	0.32	0.34	0.34	0.32	0.32	0.34	0.33	0.33	0.32	1231	45.6	2.3	4.8
Grasses	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
CWillow	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
RussOlive	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
ElmTree	223	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	32.7	2.3	4.8
AlfalfaHay	404	0.27	0.26	0.26	0.28	0.28	0.26	0.26	0.28	0.27	0.27	0.26	0	25.0	1.8	3.9
Corn	409	0.32	0.31	0.31	0.33	0.33	0.31	0.31	0.33	0.32	0.32	0.31	0	17.5	2.2	4.6
IrrPast	328	0.27	0.26	0.26	0.28	0.28	0.26	0.26	0.28	0.27	0.27	0.26	0	23.9	1.8	3.9
OatsBarley	223	0.08	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	709	25.7	0.4	1.5
Veg./Row/G	226	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	707	26.6	0.8	2.8
Trees–Fru	226	0.34	0.32	0.32	0.35	0.35	0.32	0.32	0.35	0.34	0.34	0.32	0	29.0	2.3	4.8
Trees–Nur	226	0.31	0.30	0.30	0.32	0.32	0.30	0.30	0.32	0.31	0.31	0.30	0	28.2	2.1	4.4
Yard	328	0.27	0.26	0.26	0.28	0.28	0.26	0.26	0.28	0.27	0.27	0.26	0	23.9	1.8	3.9
NEXRAD HRS AVAIL		24	24	24	24	NDFD	NDFD	NDFD	NCEP	NCEP	NCEP	NCEP				
TOTAL RAIN		0.00	0.02	0.00	0.00	0.15	0.02	0.02	0.04	0.02	0.00	0.02				
EFFECTIVE RAIN		0.00	0.02	0.00	0.00	0.15	0.02	0.02	0.04	0.02	0.00	0.02				

NEXRAD MONTHLY TOTAL RAIN:

JANUARY	0.00
FEBRUARY	0.33
MARCH	0.70
APRIL	0.33
MAY	1.13
JUNE	0.62
JULY	3.85

(2330x1485)

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Figure 8: ET Chart

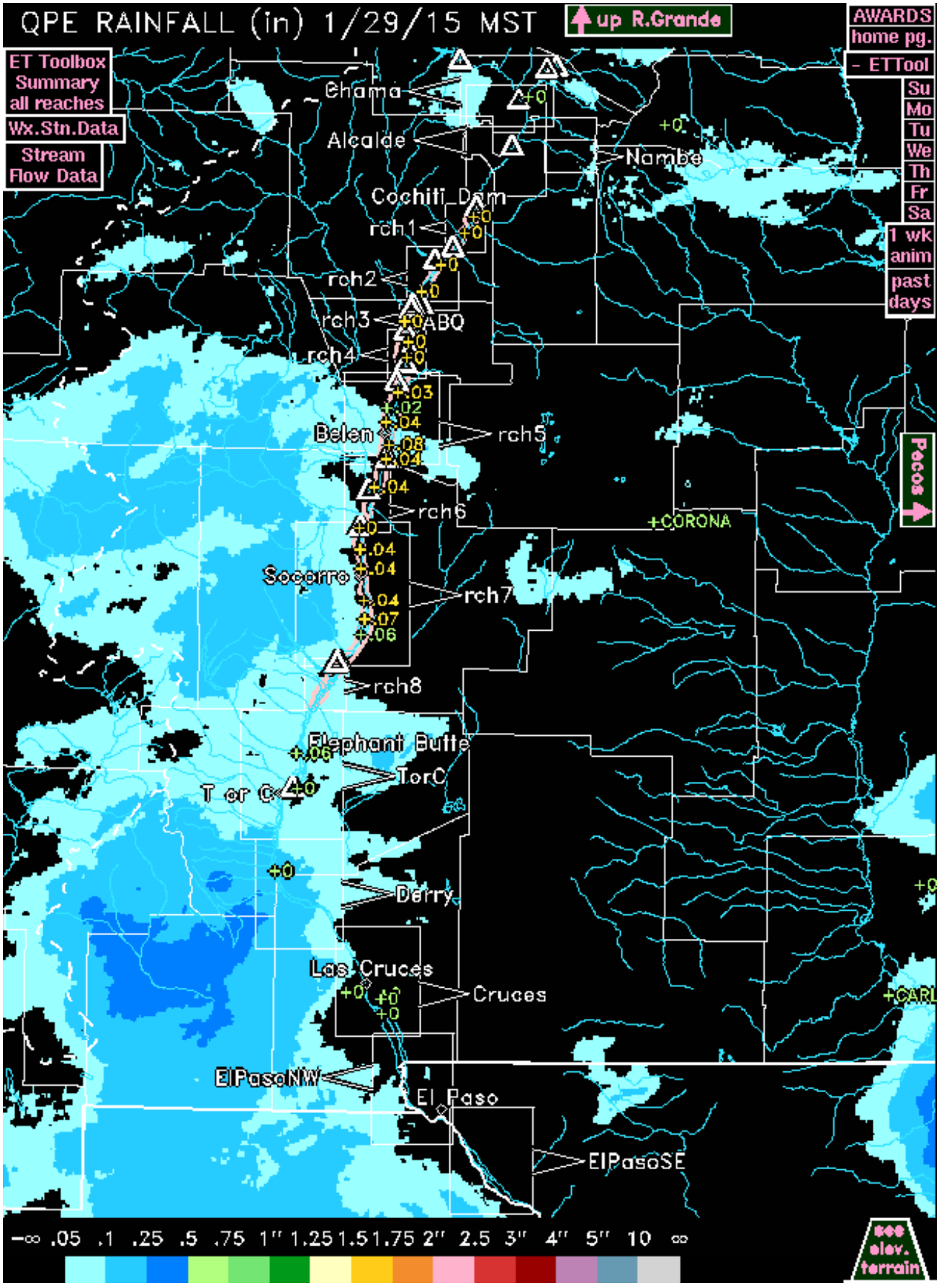

Figure 9: Rio Grande Map - ET Toolbox

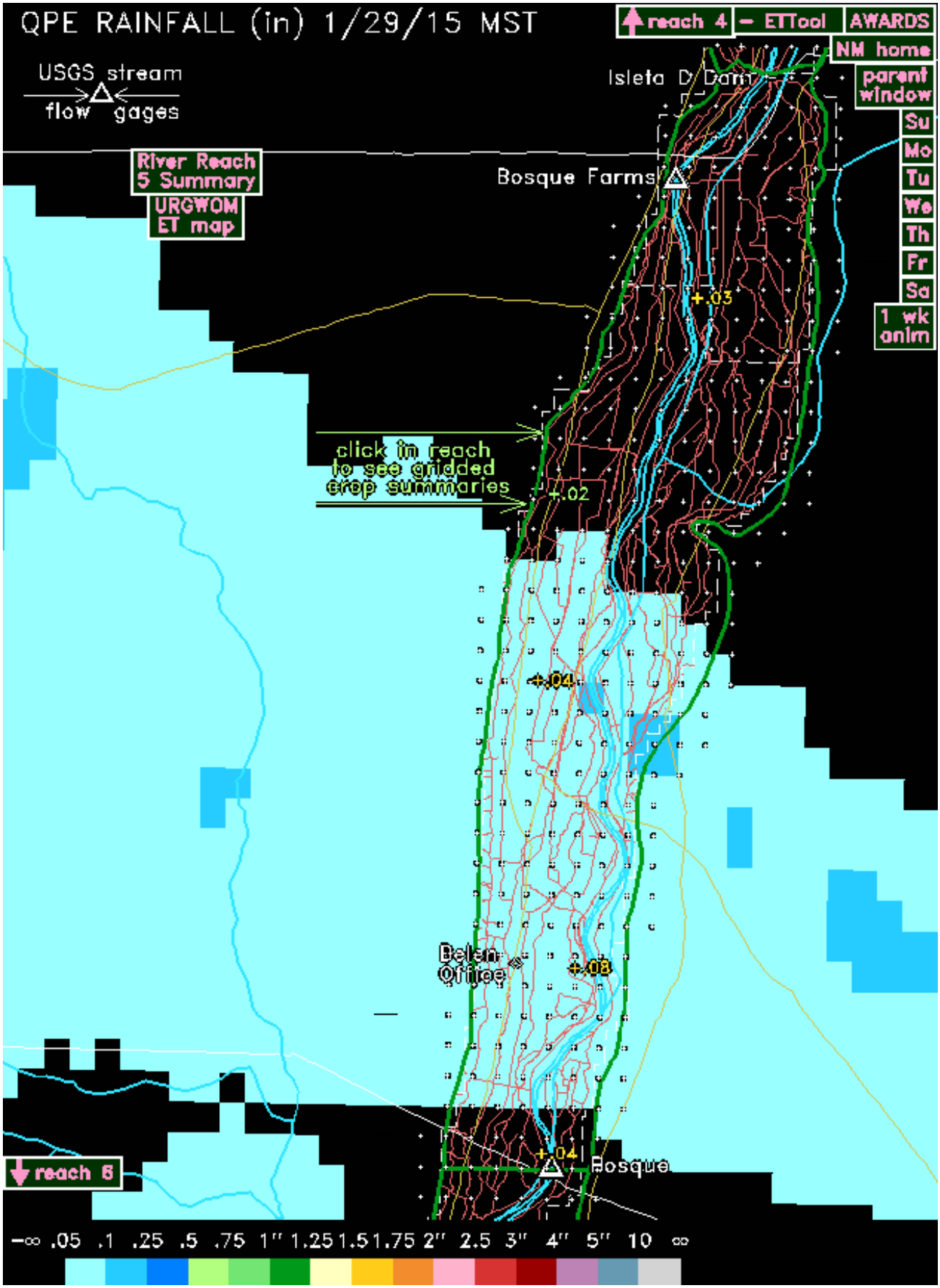

Figure 10: River Reach 5 - ET Toolbox

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ET TOOLBOX CELL DETAILS

URGWOM Reach 5 (Isleta to Bosque, NM gage)

Vegetation classification: MRGCD Ag. & IkonUSu Rip. (MRIU) (Except open water)

Cell number: 2330x1485

Weather station: Bosque Farms − NM

Note: Final values are subject to change with updated weather data, which could occur multiple times during periods of local weather station data feed instability.

Last 7 and 7 Forecast Day's URGWOM Water Use in Acre−Feet (CFS)

Consumptive Use		2014							Forecast						
Crop	Acres	July 4	July 5	July 6	July 7	July 8	July 9	July 10	July 11	July 12	July 13	July 14	July 15	July 16	July 17
Cottonwood	36.2	0.9	0.9	1.1	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.1	1.0	1.0	1.0
DTamarisk	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STamarisk	3.7	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Wetland2	8.8	0.2	0.2	0.3	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2
Grasses	4.5	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CWillow	5.3	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.1
RussOlive	2.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ElmTree	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AlfalfaHay	66.9	1.4	1.4	1.6	1.5	1.5	1.5	1.6	1.6	1.5	1.5	1.6	1.5	1.5	1.5
Corn	41.3	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
IrrPast	2.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Yard	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLO2DWater	41.1	0.9	1.0	1.1	1.0	0.9	0.9	1.2	1.2	1.1	1.1	1.2	1.1	1.1	1.1
WetSands	8.9	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.2
Totals	223.0	5.4	5.4	6.0	5.8	5.6	5.6	6.0	6.0	5.6	5.6	6.0	5.8	5.8	5.6
		(2.7)(	2.7)(	3.1)(	2.9)(	2.8)(	2.8)(	3.0)(	3.0)(	2.8)(	2.8)(	3.0)(	2.9)(	2.9)(	2.8)
Agricul.	111.4	2.5	2.5	2.8	2.7	2.6	2.6	2.8	2.8	2.6	2.6	2.8	2.7	2.7	2.6
		(1.3)(	1.3)(	1.4)(	1.4)(	1.3)(	1.3)(	1.4)(	1.4)(	1.3)(	1.3)(	1.4)(	1.4)(	1.4)(	1.3)
Riparian	61.5	1.6	1.6	1.8	1.7	1.7	1.7	1.8	1.8	1.7	1.7	1.8	1.7	1.7	1.7
		(0.8)(	0.8)(	0.9)(	0.9)(	0.8)(	0.8)(	0.9)(	0.9)(	0.8)(	0.8)(	0.9)(	0.9)(	0.9)(	0.8)
Open Water	50.1	1.3	1.3	1.5	1.4	1.3	1.3	1.4	1.4	1.3	1.3	1.4	1.4	1.4	1.3
		(0.7)(	0.7)(	0.7)(	0.7)(	0.7)(	0.7)(	0.7)(	0.7)(	0.7)(	0.7)(	0.7)(	0.7)(	0.7)(	0.7)
Urban	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		(0.0)(	0.0)(	0.0)(	0.0)(	0.0)(	0.0)(	0.0)(	0.0)(	0.0)(	0.0)(	0.0)(	0.0)(	0.0)(	0.0)
NEXRAD															
Rainfall Est.		0.1	0.8	7.2	0.0	0.1	0.0	0.0	0.7	0.1	0.1	0.2	0.1	0.0	0.1
		(0.0)(	0.4)(	3.6)(	0.0)(	0.0)(	0.0)(	0.0)(	0.4)(	0.0)(	0.0)(	0.1)(	0.0)(	0.0)(	0.0)
URGWOM															
Water Use		5.3	4.6	−1.2	5.8	5.5	5.6	6.0	5.3	5.5	5.5	5.8	5.7	5.8	5.5
		(2.7)(	2.3)(	−0.6)(	2.9)(	2.8)(	2.8)(	3.0)(	2.7)(	2.8)(	2.8)(	2.9)(	2.9)(	2.9)(	2.8)

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Figure 11: Grid Cell Detail

ET Summary Products (To-Date)

Reach 5

OPTIONS:

Table

Plot of last 14 and 7 forecast days - Total, Agriculture, Riparian, Open Water, and Urban - also Rain

Plot of last 14 and 7 forecast days - Total and Running Averages - also Stream gage

Click on red for Daily Agricultural ET Rates - Total 23470 Acres from the 2012 MRGCD Crop Reports (MRIU)

Crop	Acres	Crop	Acres	Crop	Acres	Crop	Acres
Alfalfa/Hay	10706	Corn	2729	Irrigated Pasture	8849	Oates/Barley	334
Trees-Fruit	51	Trees-Nursery	421	Vegetables/Row Crops/Garden	71	Yard	309

Click on red for Daily Riparian ET Rates - Total 4440 Acres from the 2000/2001 IKONOS/USU Rip.(MRIU)

Crop	Acres	Crop	Acres	Crop	Acres	Crop	Acres
Cottonwood (USU)	2560	Cottonwood Bosque w/inclusion of Willow	20	Cottonwood/Russian Olive/Willow mix	0	Cottonwood/Salt Cedar (Tamarisk)/Willow mix	1
Coyote Willow (USU)	609	Dense Tamarisk (USU)	122	Elm Tree (USU)	10	Grasses (USU)	213
Grassland	4	Russian Olive woodland w/inclusion of Willow	0	Russian Olives (USU)	165	Salt Cedar Woodland w/inclusion of Willow	37
Shrubland	3	Sparce Vegetation	0	Sparce Tamarisk (USU)	311	Wet Soil/wet land (USU)	384
Wetland	1	Willow	0	-----	-----	-----	-----

Click on red for Daily Open Water Evaporation Rates - Variable Acres

Figure 12: ET Summary Products Menu - Reach 5

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ET TOOLBOX REACH SUMMARY

Summary for: URGWOM Reach 5 (Isleta to Bosque, NM gage)

Vegetation classification: MRGCD Ag. & IkonUSu Rip. (MRIU) (Except open water)

ET TOOLBOX classes (ag. + rip. + open water + urb.): 29817.7 acres

(Daily URGWOM Water Use = Daily Consumptive Use Total − Rain)

Note: Final values are subject to change with updated weather data, which could occur multiple times during periods of local weather station data feed instability.

			Daily Consumptive Use					Daily	Daily URGWOM Water Use			Total URGWOM Water	Daily Flow Difference		
2014 Month	Day	M	Total CFS	Agriculture CFS	Riparian CFS	Open Water CFS	Urban CFS	Rain CFS	Total CFS	5−Day Avg. CFS	10−Day Avg. CFS	Use To−Date Since Jan. 1, 2014 AC−FT	Total CFS	5−Day Avg. CFS	10−Day Avg. CFS
July	17	F	352.5	264.6	61.8	26.1	0.0	1.3	351.2	359.0	355.0	71520.0	None	None	None
July	16	F	361.8	271.3	63.9	26.7	0.0	0.0	361.8	359.6	354.3	70824.6	None	None	None
July	15	F	361.8	271.3	63.9	26.7	0.0	1.3	360.5	358.7	340.0	70108.2	None	None	None
July	14	F	371.5	278.7	65.4	27.4	0.0	2.7	368.8	359.3	337.4	69394.4	None	None	None
July	13	F	354.2	266.1	61.9	26.2	0.0	1.7	352.6	353.9	334.3	68664.1	None	None	None
July	12	F	356.2	267.5	62.3	26.4	0.0	1.7	354.5	351.0	321.6	67966.1	None	None	None
July	11	F	371.0	278.4	65.2	27.3	0.0	13.6	357.4	349.0	316.8	67264.2	None	None	None
July	10		363.4	272.4	64.2	26.8	0.0	0.3	363.1	321.2	305.4	66556.6	None	None	None
July	9		342.9	257.7	59.6	25.6	0.0	0.8	342.0	315.6	309.6	65837.7	None	None	None
July	8		339.9	255.5	59.1	25.3	0.0	2.0	337.9	314.7	316.7	65160.4	None	None	None
July	7		345.7	259.4	60.6	25.7	0.0	1.2	344.5	292.2	321.8	64491.4	None	None	None
July	6		349.7	262.3	61.2	26.2	0.0	131.3	218.4	284.5	322.6	63809.2	None	None	None
July	5		349.9	263.2	60.9	25.8	0.0	14.8	335.1	289.6	341.1	63376.7	None	None	None
July	4		340.1	256.2	58.7	25.2	0.0	2.4	337.7	303.6	347.1	62713.2	None	None	None
July	3		337.2	252.2	59.6	25.4	0.0	111.8	225.4	318.6	352.7	62044.4	None	None	None
July	2		342.0	256.5	59.9	25.6	0.0	36.0	305.9	351.4	369.0	61598.2	None	None	None
July	1		365.3	273.9	64.0	27.4	0.0	121.6	243.6	360.7	378.0	60992.4	None	None	None
June	30		418.3	312.1	74.3	31.9	0.0	13.1	405.2	392.6	392.3	60510.0	None	None	None
June	29		413.0	308.5	73.0	31.5	0.0	0.0	413.0	390.7	390.4	59707.8	None	None	None
June	28		389.0	291.0	68.6	29.4	0.0	0.0	389.0	386.7	385.2	58890.0	None	None	None
June	27		352.8	265.3	60.9	26.7	0.0	0.0	352.8	386.7	381.3	58119.7	None	None	None
June	26		408.0	304.5	72.2	31.4	0.0	5.1	402.9	395.4	380.4	57421.0	None	None	None
June	25		395.5	295.5	69.5	30.6	0.0	0.0	395.5	392.0	378.4	56623.3	None	None	None
June	24		393.4	293.5	69.4	30.5	0.0	0.0	393.4	390.2	376.9	55840.1	None	None	None
June	23		388.8	291.4	68.0	29.4	0.0	0.0	388.8	383.6	375.4	55061.3	None	None	None
June	22		396.4	296.2	69.6	30.6	0.0	0.2	396.2	376.0	368.6	54291.4	None	None	None
June	21		386.2	288.4	67.9	29.9	0.0	0.0	386.2	365.5	366.8	53507.0	None	None	None
June	20		386.3	288.6	67.9	29.9	0.0	0.0	386.3	364.7	364.9	52742.4	None	None	None
June	19		360.4	270.5	62.5	27.5	0.0	0.0	360.4	363.6	363.5	51977.4	None	None	None
June	18		359.7	269.5	62.7	27.6	0.0	8.9	350.8	367.2	362.6	51263.8	None	None	None
June	17		372.4	279.2	64.7	28.5	0.0	28.7	343.7	361.2	362.3	50569.3	None	None	None
June	16		382.5	285.6	67.1	29.8	0.0	0.0	382.5	368.2	366.3	49888.8	None	None	None
June	15		380.7	283.6	67.0	30.0	0.0	0.0	380.7	365.1	368.0	49131.5	None	None	None
June	14		378.4	282.4	66.4	29.5	0.0	0.0	378.4	363.5	370.6	48377.8	None	None	None
June	13		337.9	253.3	58.3	26.3	0.0	17.2	320.6	358.0	373.6	47628.6	None	None	None
June	12		378.9	282.1	66.7	30.1	0.0	0.0	378.9	363.5	383.8	46993.7	None	None	None
June	11		370.2	276.4	64.8	29.0	0.0	3.3	366.9	364.3	384.9	46243.4	None	None	None
June	10		372.4	276.9	66.0	29.5	0.0	0.0	372.4	370.9	385.5	45517.0	None	None	None
Jan.	6		5.8	0.0	0.9	4.8	0.0	0.0	5.8	7.4	None	91.1	None	None	None
Jan.	5		5.8	0.0	0.9	4.8	0.0	0.0	5.8	8.0	None	79.7	None	None	None
Jan.	4		9.2	0.0	1.6	7.6	0.0	0.0	9.2	None	None	68.3	None	None	None
Jan.	3		8.7	0.0	1.5	7.2	0.0	0.0	8.7	None	None	50.1	None	None	None
Jan.	2		7.6	0.0	1.3	6.3	0.0	0.0	7.6	None	None	33.0	None	None	None
Jan.	1		9.1	0.0	1.5	7.5	0.0	0.0	9.1	None	None	18.0	None	None	None

Irrigated Ag acreage = 23469.6
Riparian acreage = 4442.3
Open Water acreage = 1905.7 (daily variable)
Urban acreage = 0.0
Total (ag. + rip. + open water + urb.) = 29817.7 acres
Fallow acreage = 0.0
Idle acreage = 0.0

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Figure 13: Reach 5 Summary

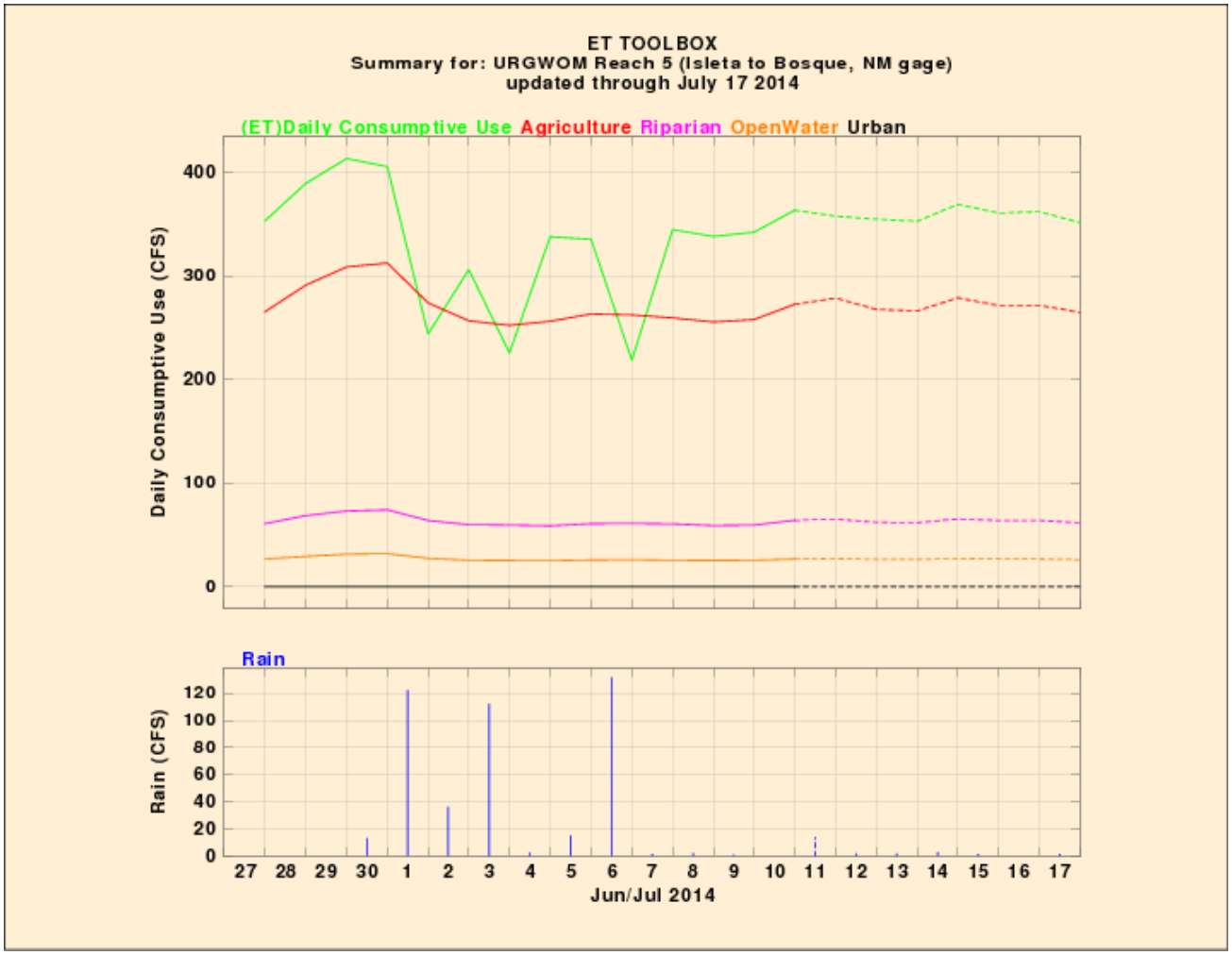

Figure 14: Reach 5 Daily Consumptive Use And Rainfall

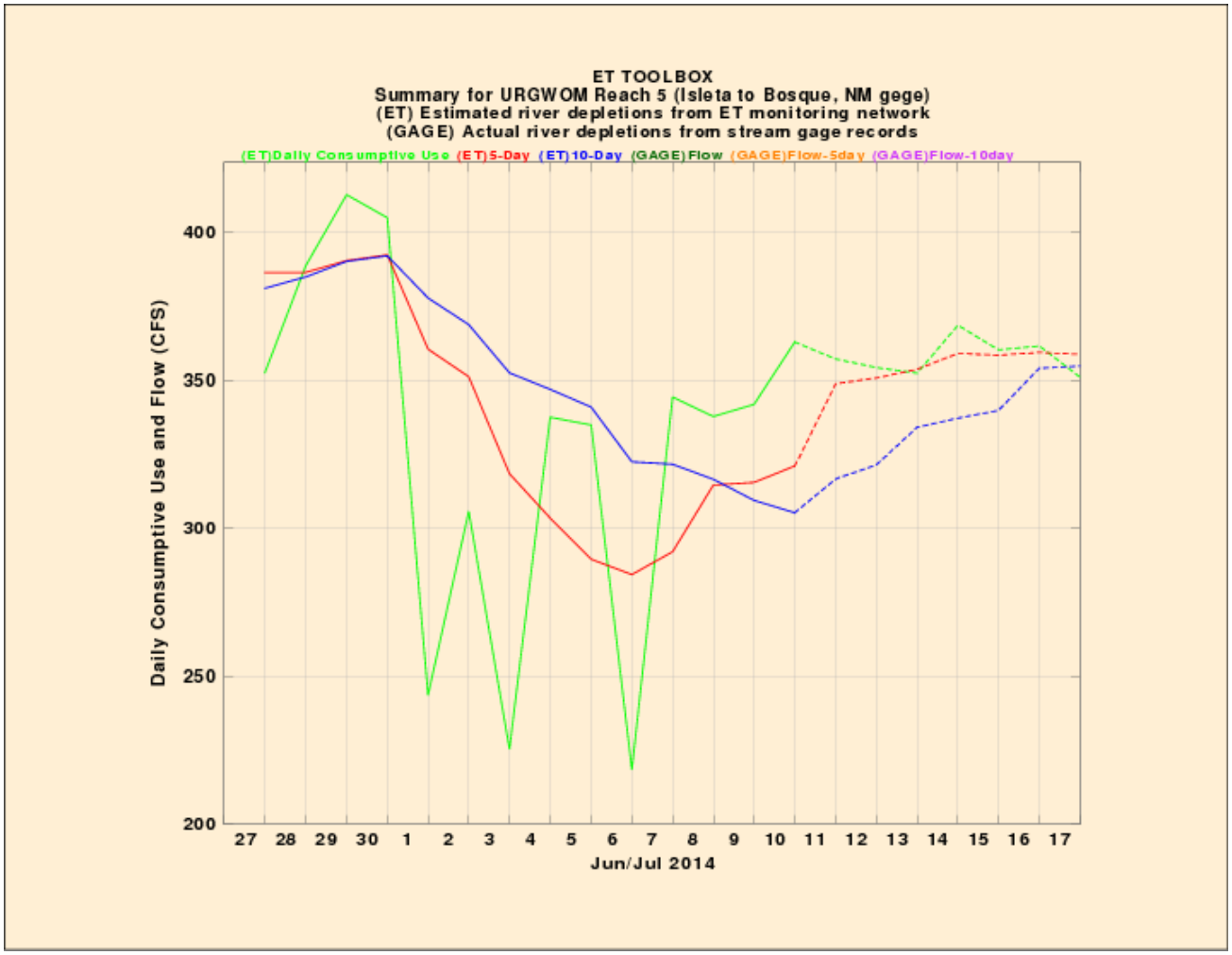

Figure 15: Reach 5 Daily Consumptive Use With Stream Flow And Running Averages

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URGWOM Reach 5 (Isleta to Bosque, NM gage)

Daily ET Rates for AlfalfaHay Today is: July 11, 2014

Vegetation Classification: MRGCD Ag. & IkonUSu Rip. (MRIU)
Class Number: 401
Number of 1x1 km cells = 272 Number with AlfalfaHay = 245
Weather station(s) used:
1) BWWN Bosque Farms − NM
2) TBFN Toni Barrow Farm − NM
3) JRLN Jarales − So. of Belen, NM
4) ASFN Adolf Sanchez Farm − NM
Plant and Terminate Dates, Hargreaves Reference (Ref.) ET, and
Crop Coef. are averaged from above weather station(s)
Crop ET = Ref. ET x Crop Coef.
Total Water Use = Sum of cell water use
NEXRAD Rain = Sum of (cell rain x cell crop acres/12)
URGWOM Water Use = Total Water Use − NEXRAD Rain

Acres: 10706 Plant Date: Mar. 23 Termination Date:

Month Day (2014)	Ref. ET (IN)	Crop Coef.	Crop ET (IN)	Total Water Use (AC−FT)	NEXRAD Rain (AC−FT)	URGWOM Water Use (AC−FT)
Mar. 23	0.14	0.40	0.06	53.47	0.00	53.47
Mar. 24	0.15	0.40	0.06	53.47	0.00	53.47
June 1	0.30	0.95	0.28	249.86	0.16	249.70
June 2	0.31	0.95	0.29	258.05	0.00	258.05
June 3	0.34	0.95	0.32	280.94	0.00	280.94
June 4	0.32	0.95	0.31	270.42	0.00	270.42
June 5	0.33	0.95	0.31	270.30	0.00	270.30
June 6	0.32	0.95	0.30	264.18	0.00	264.18
June 18	0.28	0.95	0.26	237.41	72.30	165.11
June 19	0.28	0.95	0.26	237.44	0.00	237.44
June 20	0.30	0.95	0.28	252.70	0.00	252.70
June 21	0.30	0.95	0.28	252.70	0.00	252.70
June 22	0.31	0.95	0.30	260.40	1.67	258.73
June 23	0.30	0.95	0.28	255.41	0.00	255.41
June 24	0.31	0.95	0.29	256.99	0.00	256.99
June 25	0.31	0.95	0.30	259.82	0.00	259.82
June 26	0.32	0.95	0.30	266.99	46.77	220.22
June 27	0.27	0.95	0.26	235.35	0.00	235.35
June 28	0.31	0.95	0.29	256.11	0.00	256.11
June 29	0.32	0.95	0.30	270.43	0.00	270.43
June 30	0.33	0.95	0.31	275.48	92.49	182.99
June Totals	8.99		8.54	7596.99	617.22	6979.77
July 1	0.28	0.95	0.27	242.52	947.01	−704.49
July 2	0.26	0.95	0.25	225.91	414.01	−188.10
July 3	0.25	0.95	0.24	220.70	1064.77	−844.07
July 4	0.26	0.95	0.25	228.07	26.23	201.84
July 5	0.27	0.95	0.26	235.29	118.78	116.51
July 6	0.27	0.95	0.25	231.31	920.28	−688.97
July 7	0.27	0.95	0.25	230.18	12.97	217.21
July 8	0.26	0.95	0.25	227.42	38.02	189.40
July 9	0.27	0.95	0.25	230.86	10.24	220.62
July 10	0.28	0.95	0.27	243.60	4.54	239.06
July Totals	2.68		2.55	2315.86	3556.86	−1240.99
Total To−Date	25.75		25.23	22385.10	6164.12	16220.98

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Figure 16: Daily ET Rates

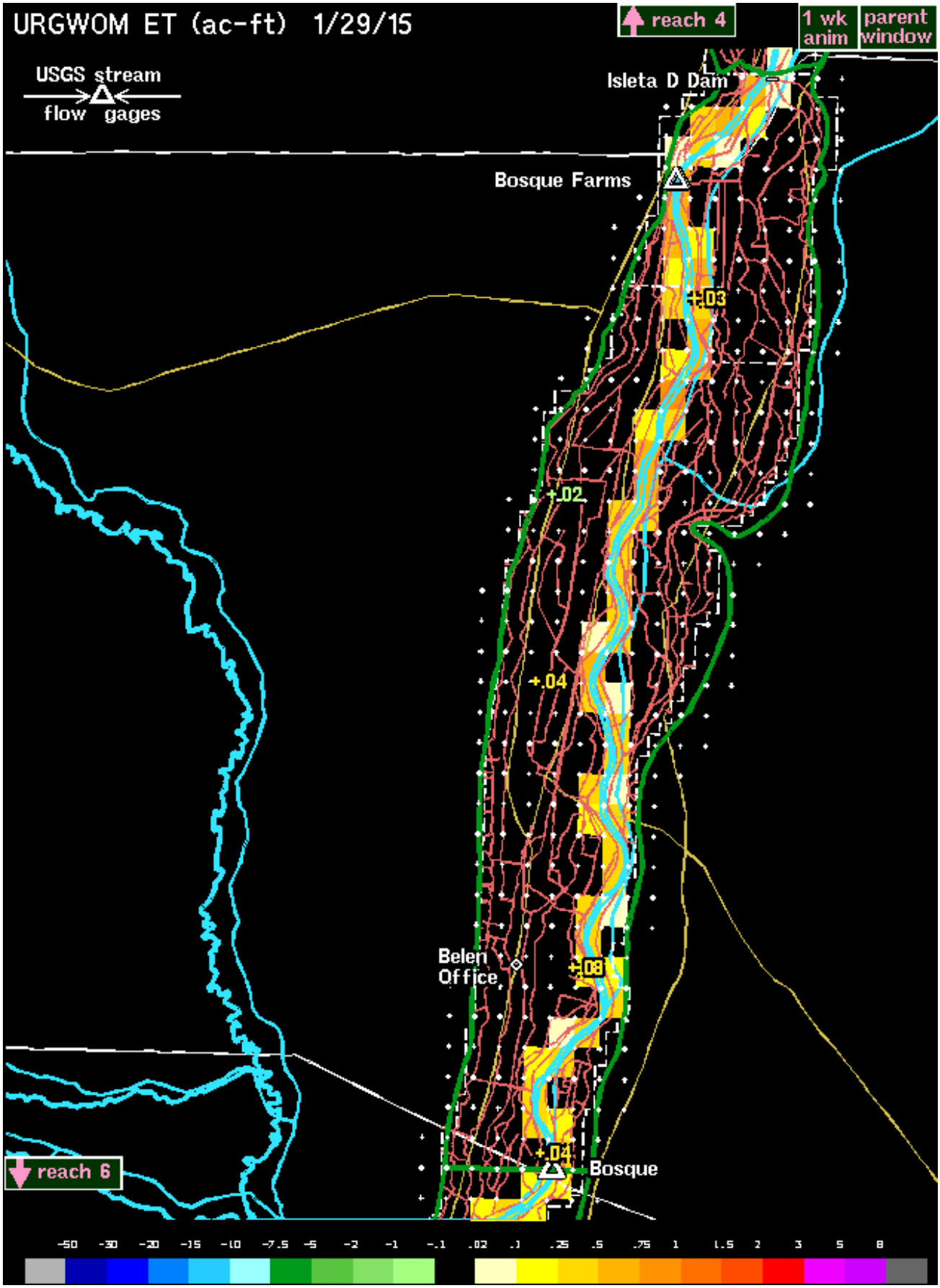

Figure 17: URGWOM ET - Reach 5

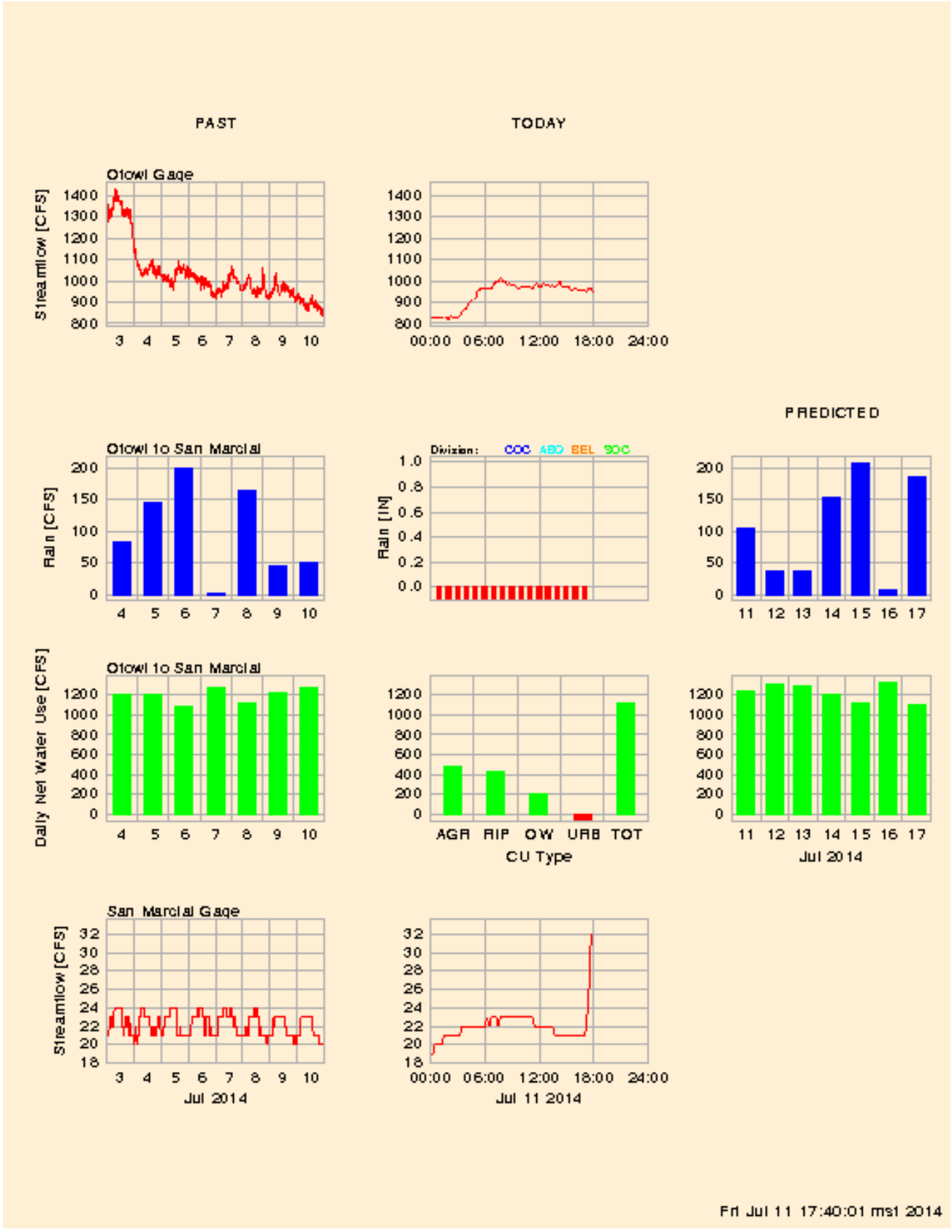

Figure 18: With Present Division Rain Matrix

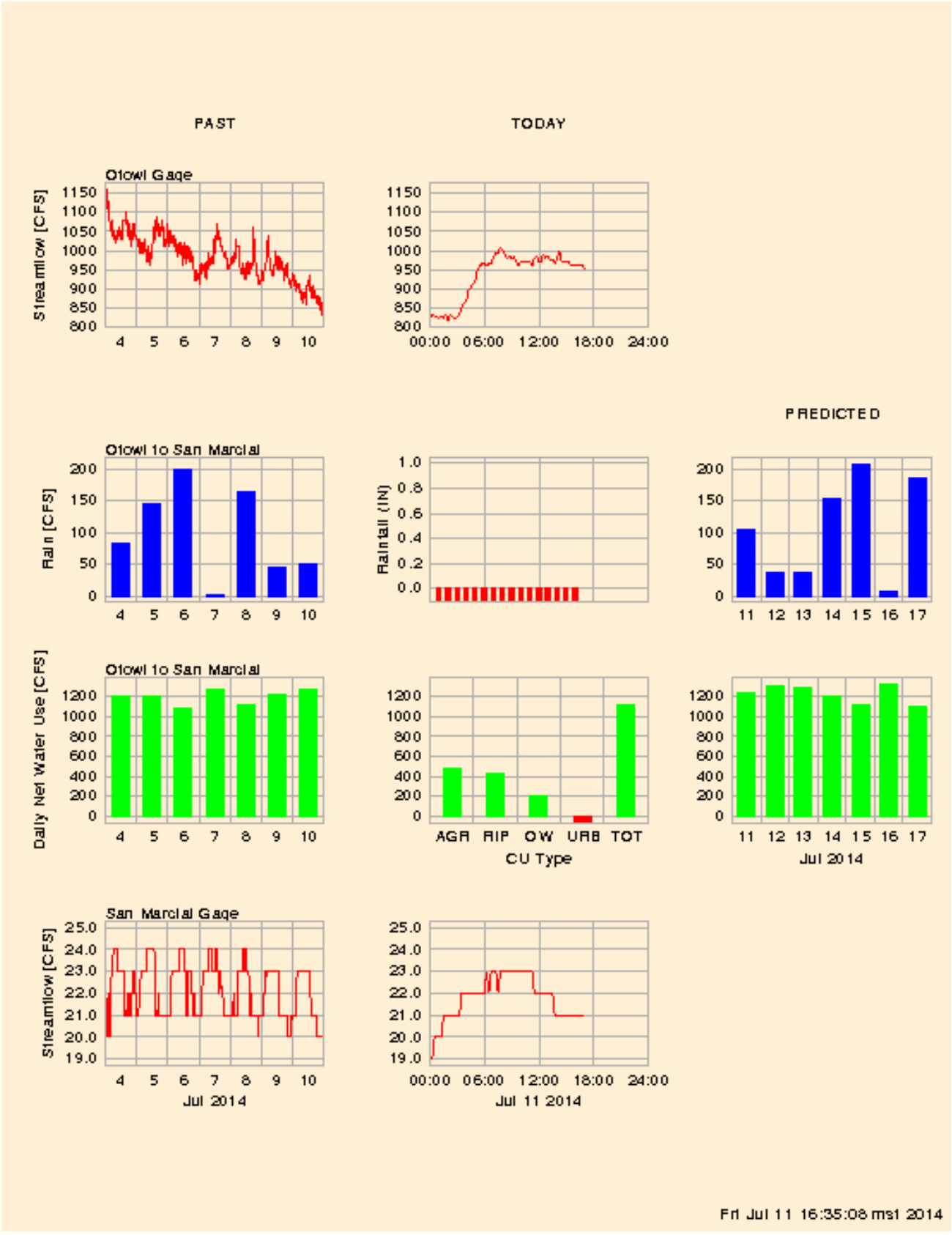

Figure 19: With Present Hourly Rain Matrix

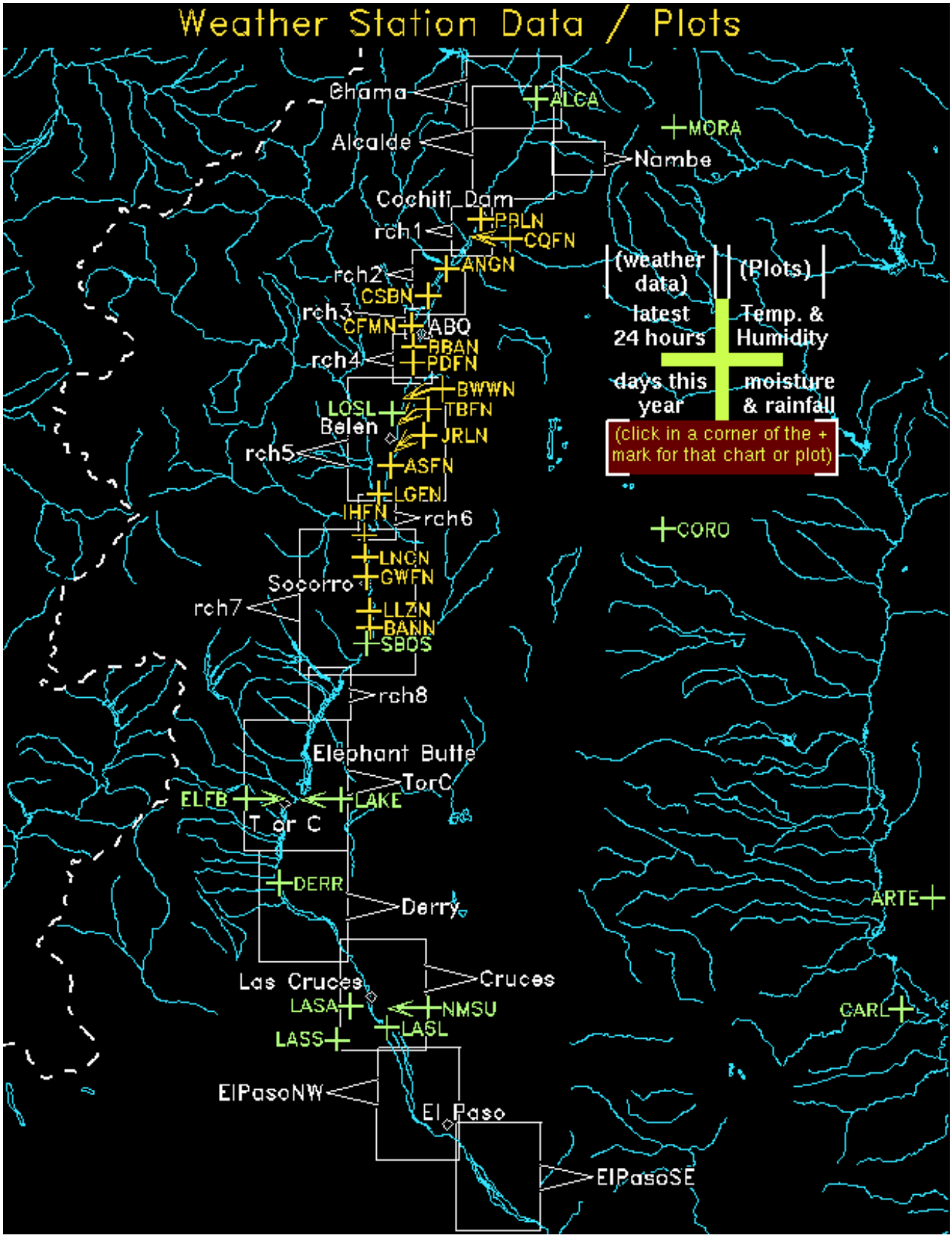

Figure 20: MRGCD Weather Station Network

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Bosque Farms – NM – MRGCD BWWN

Hourly Weather Data for Last 24–Hours – 2014

Month	Day	Time (MST)	Temp. (F)	Wind (Mi/Hr)	Wind Dir. (Deg)	Rel. Hum. (%)	Rain (in)	Solar Radiation (Mj/Sq m)	Soil Temp. (F)	Vol. Soil Water Content
July	11	2PM	94.0	3.4	127	20	0.00	3.18	85.1	93.0
July	11	1PM	92.2	1.9	98	22	0.00	3.17	83.6	93.0
July	11	12AM	91.6	1.7	351	24	0.00	3.47	82.2	93.0
July	11	11AM	89.6	1.9	322	27	0.00	3.27	81.3	93.0
July	11	10AM	87.5	0.4	319	29	0.00	2.95	80.7	93.0
July	11	9AM	83.7	0.8	329	36	0.00	2.46	80.3	93.0
July	11	8AM	79.9	0.4	267	43	0.00	1.85	80.3	93.1
July	11	7AM	75.7	0.0	0	53	0.00	1.17	80.6	93.1
July	11	6AM	66.4	0.0	0	75	0.00	0.40	81.2	93.2
July	11	5AM	62.2	0.0	0	82	0.00	0.06	81.8	93.2
July	11	4AM	62.9	0.0	241	80	0.00	0.00	82.5	93.2
July	11	3AM	63.0	0.0	0	83	0.00	0.00	83.1	93.3
July	11	2AM	65.3	0.2	195	77	0.00	0.00	83.8	93.3
July	11	1AM	66.9	0.3	340	75	0.00	0.00	84.4	93.3
July	10	12PM	69.4	0.1	126	65	0.00	0.00	85.1	93.3
July	10	11PM	69.3	0.4	354	65	0.00	0.00	85.8	93.4
July	10	10PM	70.0	0.0	313	61	0.00	0.00	86.5	93.4
July	10	9PM	71.0	1.0	153	56	0.00	0.00	87.2	93.4
July	10	8PM	74.8	0.5	174	49	0.00	0.00	87.8	93.4
July	10	7PM	78.3	1.8	140	42	0.00	0.07	88.2	93.3
July	10	6PM	79.1	3.0	274	41	0.00	0.18	88.4	93.3
July	10	5PM	81.6	6.5	246	34	0.00	0.54	88.1	93.2
July	10	4PM	86.0	8.8	191	30	0.00	1.08	87.2	93.1
July	10	3PM	92.8	1.6	130	23	0.00	2.75	85.9	93.0

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Figure 21: MRGCD Hourly Weather Data

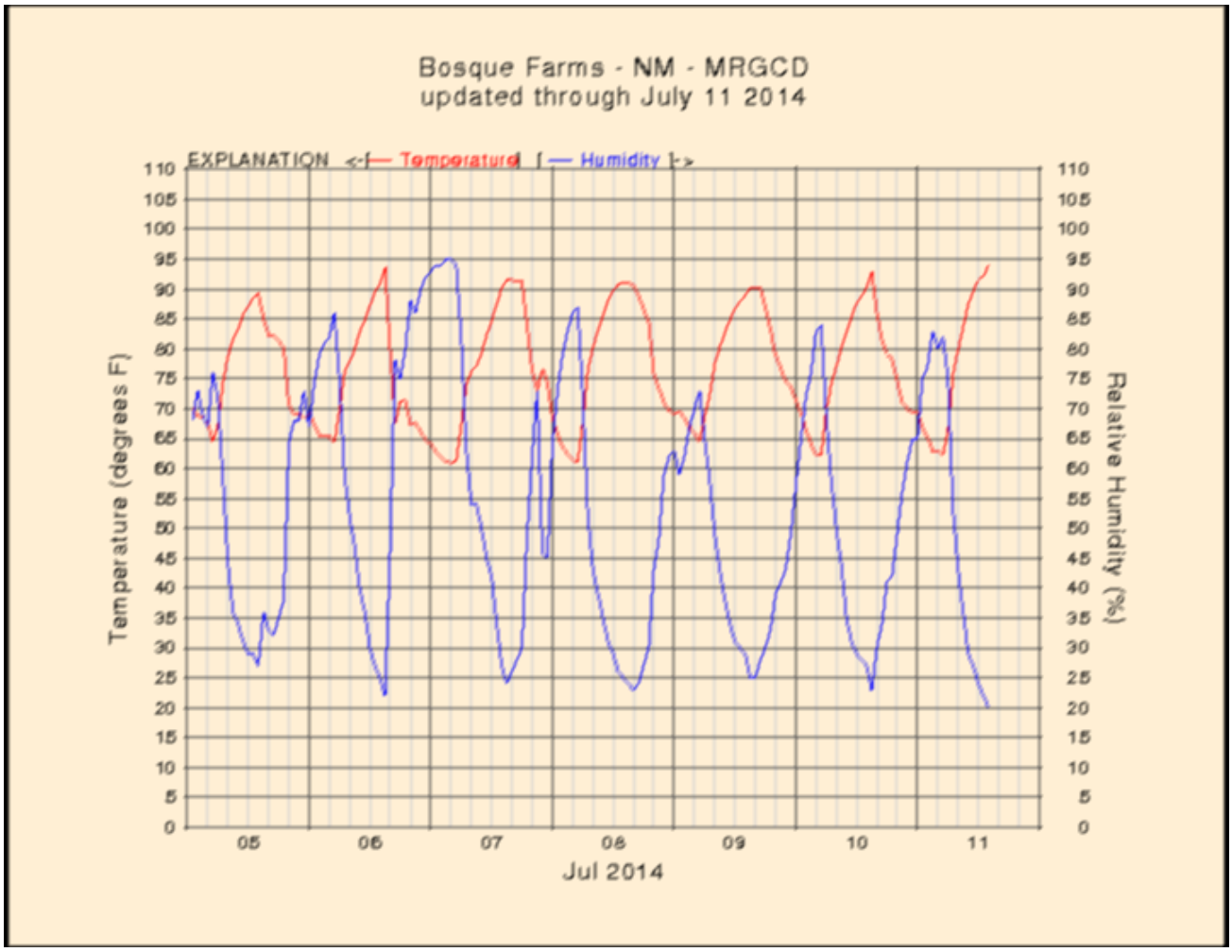

Figure 22: MRGCD Temperature-Humidity Plot

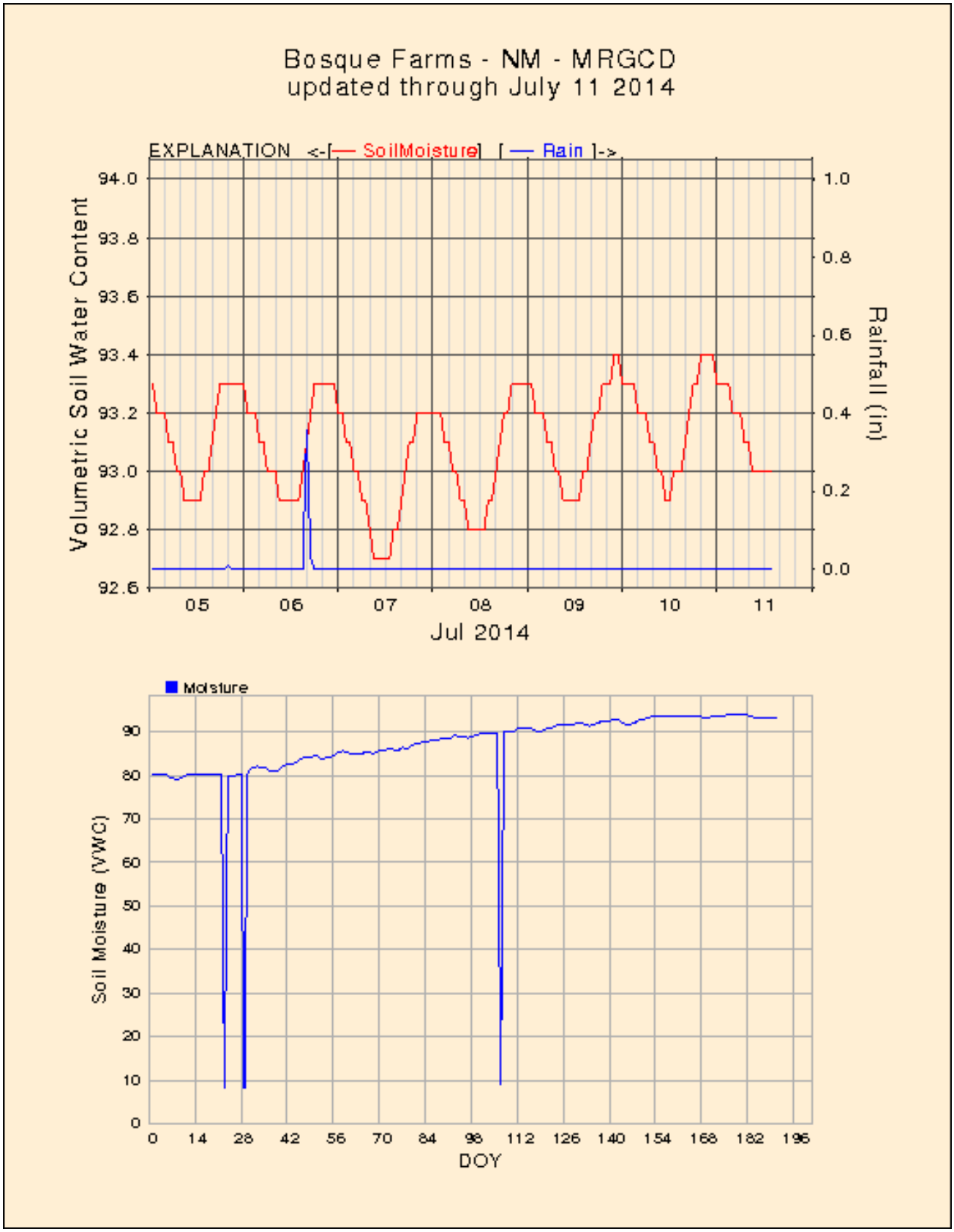

Figure 23: MRGCD Volumetric Soil Water Content Plot

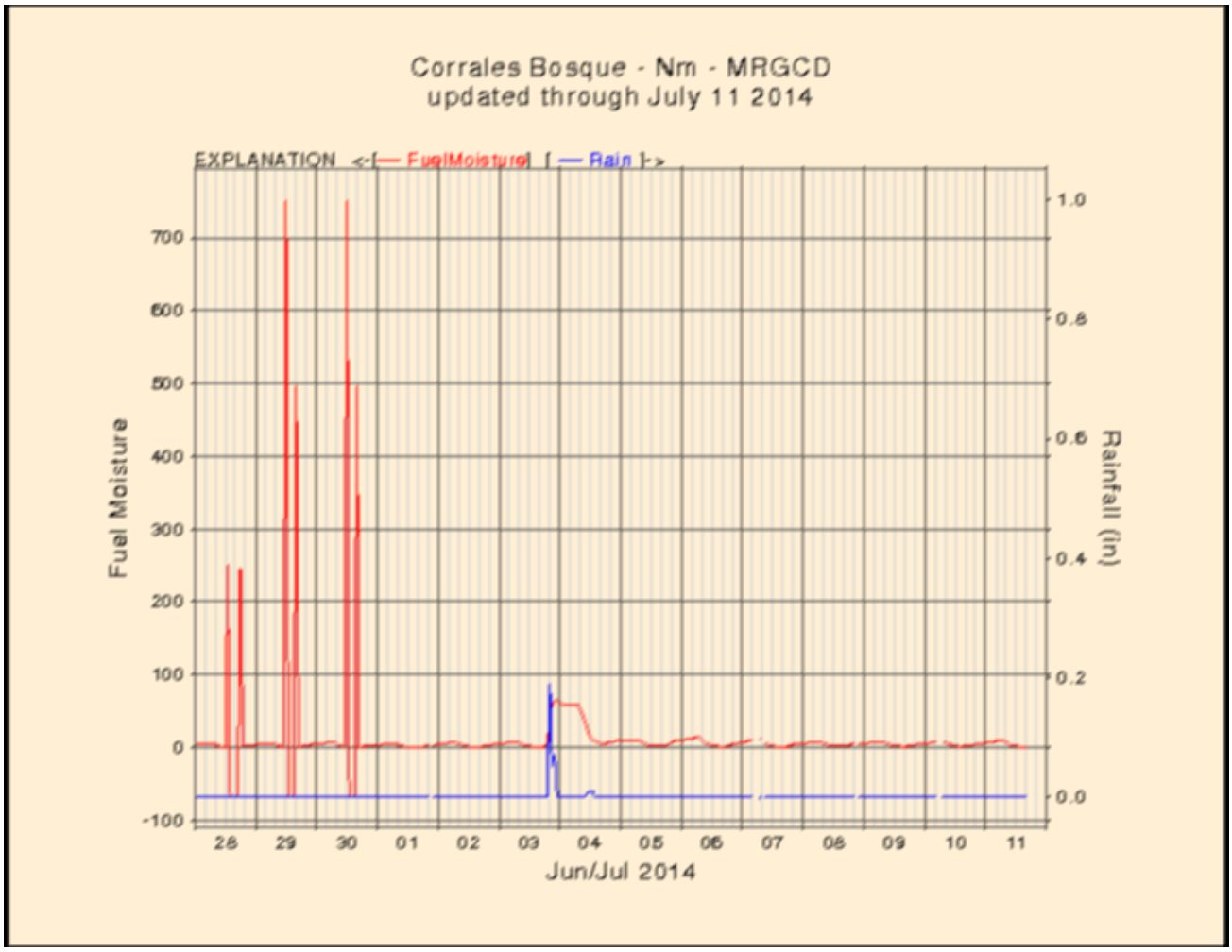

Figure 24: MRGCD Fuel Moisture Plot

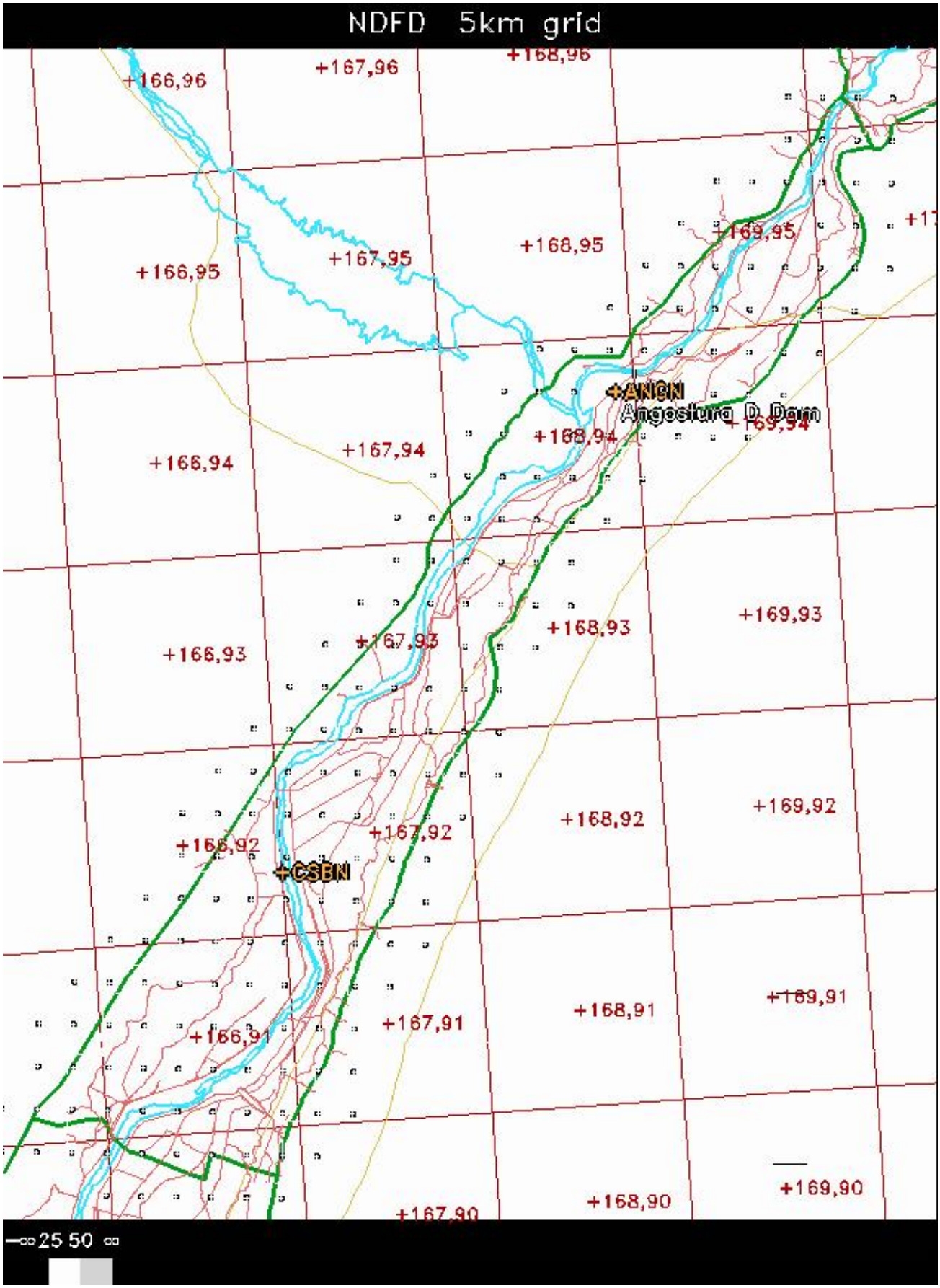

Figure 25: 5-km NDFD Grid For Reach 2

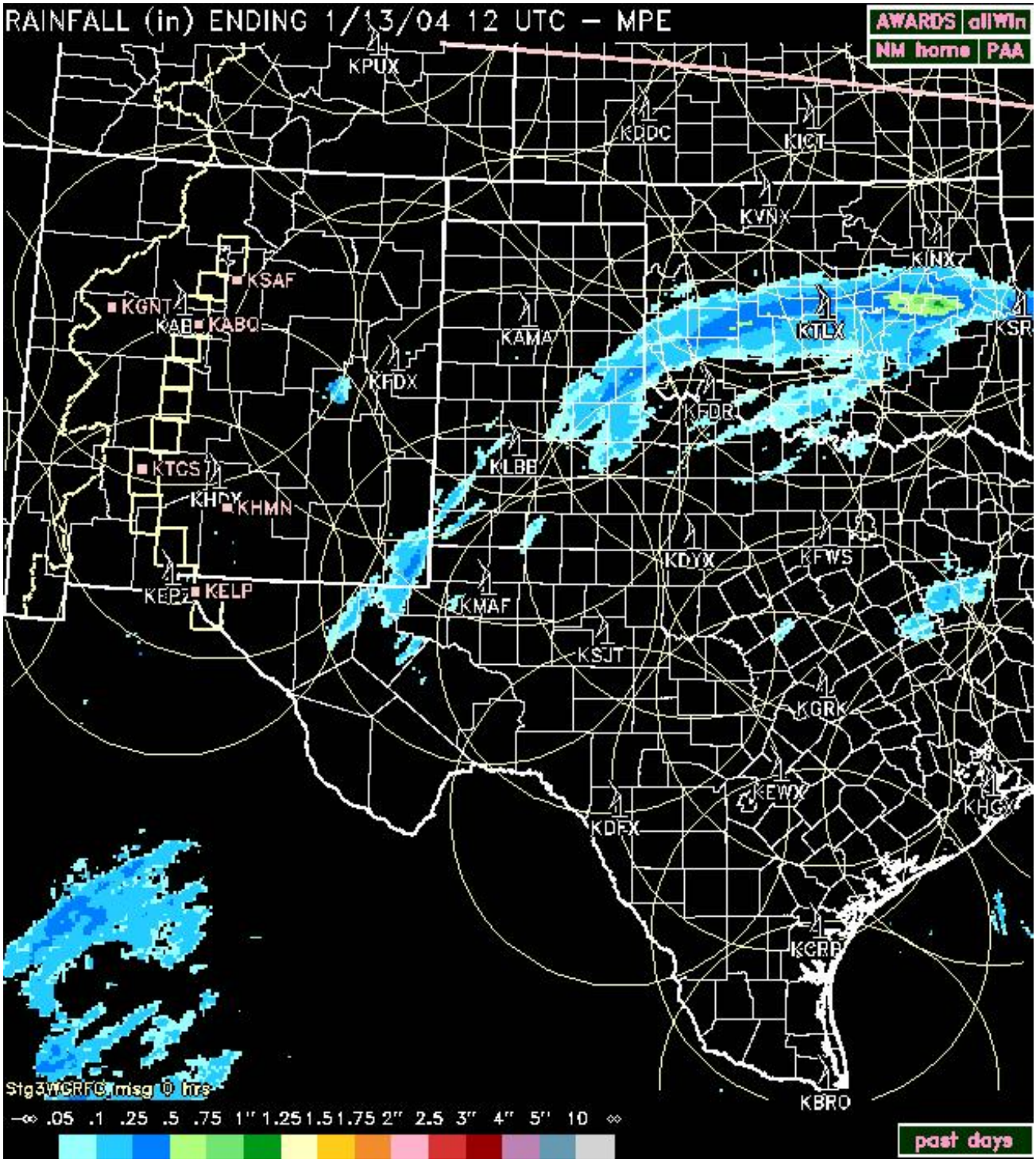

Figure 26: New Mexico, Texas, and Oklahoma Radar Coverage

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```
      subroutine refhg
c
c 1985 Hargreaves equation for reference et (ETo).
c  This was provided to Al Brower on Aug. 4, 2010
c  from Brian Westfall of Keller-Bliesner Engineering, LLC.
c  This is based on a grass reference.
c
c
c List of Input Values
c
c  Name     Units                Description
c  ------   ------------------   -------------------------
c  lat      decimal deg.         latitude
c  xjuday                        julian date
c  tmax     deg.C                maximum temperature
c  tmin     deg.C                minimum temperature
c
      include 'refet.common'
      real latrad
c
c Initalize
c
      tavg=(tmax+tmin)/2.
      pi=3.1416
      gsc=0.0820
c
c Get extraterrestrial radiation ra
c
      latrad=pi/180.*lat
      dr=1.0+(0.033*cos(2.*pi/365.*xjuday))
      sd=0.409*sin(2.*pi/365.*xjuday-1.39)
      sra=acos(-tan(latrad)*tan(sd))
      ra=(24.*60./pi)*gsc*dr*(sra*sin(latrad)*sin(sd) + cos
(latrad)*
     2 cos(sd)*sin(sra))
      ra=ra/2.45
c
c Get ret (mm/day)
c
      ret=0.0
      tr=tmax-tmin
      t=(tr)**(0.5)
      ret = .0023 * t * (tavg+17.8) * ra
      if(tr .lt. 0.0)ret=0.0
c
c Find reference et (in/day)
c
   20 value = ret*.03937
c
c Print values if debug is True, as set in parameter file.
c
```

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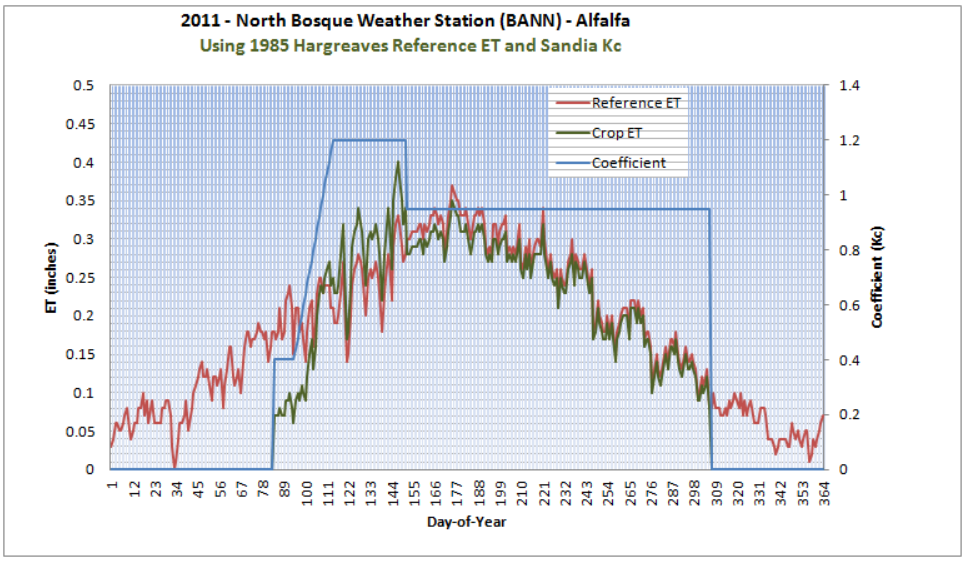
```
      if(debug)then
        write(status,*)'      Hargreaves:'
        write(status,*)'        lat=',lat
        write(status,*)'        tmax=',tmax
        write(status,*)'        tmin=',tmin
        write(status,*)'        tavg=',tavg
        write(status,*)'        pi=',pi
        write(status,*)'        gsc=',gsc
        write(status,*)'        latrad=',latrad
        write(status,*)'        xjuday=',xjuday
        write(status,*)'        dr=',dr
        write(status,*)'        sd=',sd
        write(status,*)'        sra=',sra
        write(status,*)'        ra=',ra
        write(status,*)'        tr=',tr
        write(status,*)'        t=',t
        write(status,*)'        ret=',ret
        write(status,*)'        value=',value
      endif
      return
      end
```

Monday November 17, 2014 Hargreavesequation.tex 1/1

Figure 27: Hargreaves Reference ET Equation

Figure 28: Alfalfa Curve # 11

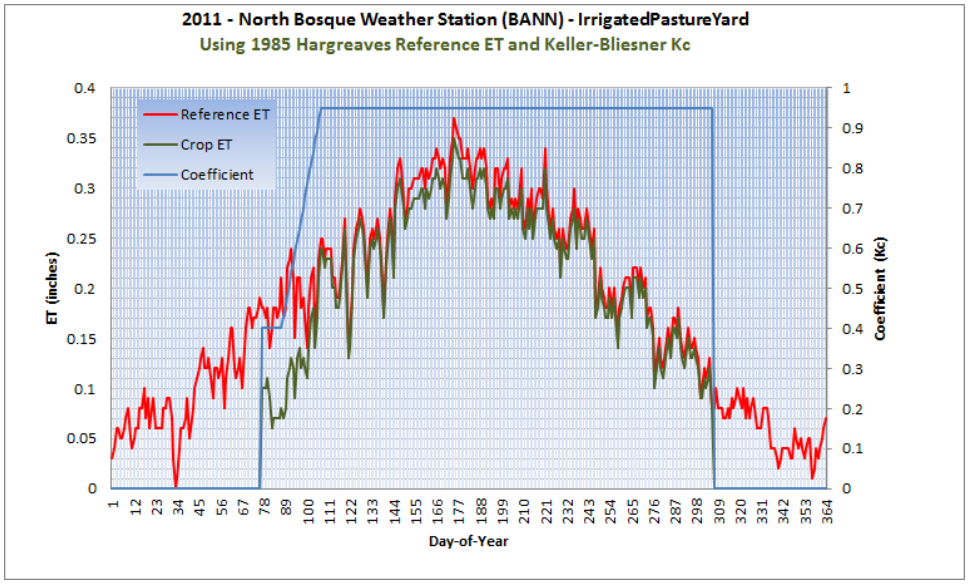


Crop coefficients Kc are based on Development Stages with Temp. in deg. F. and Lengths L in days

Crop	Cc	Start temp.	End temp.	L_ini	L_dev	L_mid	L_late	Kc_ini	Kc_dev	Kc_mid	Kc_end
Alfalfa	11	25 0	25 0	10	20	20	10	.4	1.2	1.2	.95

Note: Alfalfa - 1st 10 days after last 25 F. day = 0.4, next 20 days ramp up to 1.2 which is .04 per day, from there to end of May 1.2, and .95 after that until first 25 F. day in the fall when it is set back to zero. Above was suggestion by Arron Buetler and Brian Westfall of Keller-Bliesner Engr. and modified by Jesse Roach of Sandia Nat. Labs.

Figure 29: IrrigatedPastureYard Curve # 12

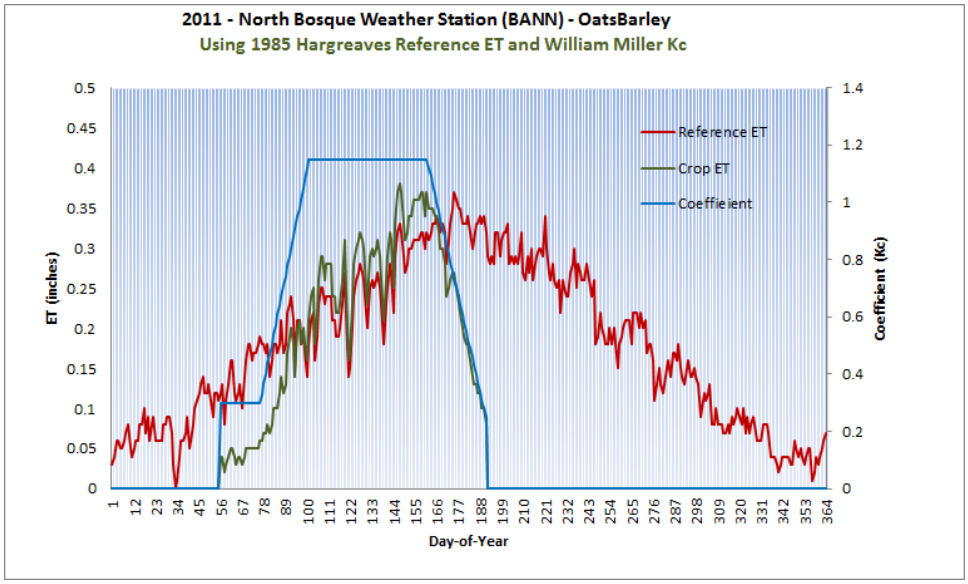


Crop coefficients Kc are based on Development Stages with Temp. in deg. F. and Lengths L in days

Crop	Cc	Start temp.	End temp.	L_ini	L_dev	L_mid	L_late	Kc_ini	Kc_dev	Kc_mid	Kc_end
IrrPasYard	12	25 -7	25 +7	10	20	270	40	.4	.95	.95	.85

Notes: IrrPasYard - starts 7 days before last 25 F. day = 0.4, next 20 days ramp up to .95 which is .0275 per day, from there .95 until L_late, then .85 until 7-days after first 25 F. day in the fall when it is set back to zero. Above was suggestion by Arron Buetler and Brian Westfall of Keller-Bliesner Engr.

Figure 30: OatsBarley Curve # 21

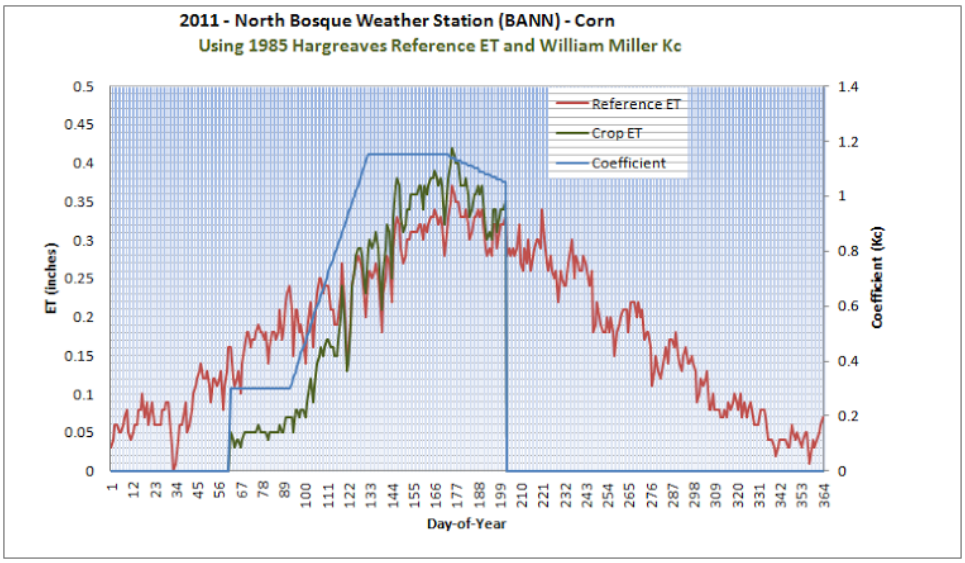


Crop coefficients Kc are based on Development Stages with Temp. in deg. F. and Lengths L in days

Crop	Cc	Start temp.	End temp.	L_ini	L_dev	L_mid	L_late	Kc_ini	Kc_dev	Kc_mid	Kc_end
Oats-Bar	21	45	0	20	25	60	30	.3	1.15	1.15	.25

Notes: Above from Bill Miller (William J. Miller Engineers, Inc) on May 14, 2012
Subject - Upper rio Grande Water operations Model, Middle Rio Grande
Valley crop Acerage Consolidations and Depletion Computations
February 13, 2012 draft

Figure 31: Corn Curve # 22

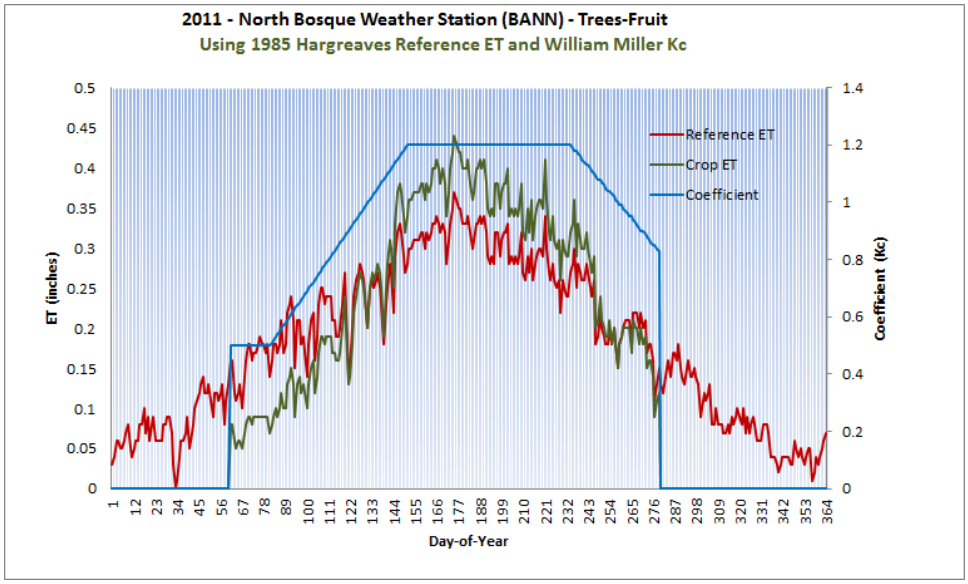


Crop coefficients Kc are based on Development Stages with Temp. in deg. F. and Lengths L in days

Crop	Cc	Start temp.	End temp.	L_ini	L_dev	L_mid	L_late	Kc_ini	Kc_dev	Kc_mid	Kc_end
Corn	22	55	32	30	40	40	30	.3	1.15	1.15	1.05

Notes: Above from Bill Miller (William J. Miller Engineers, Inc) on May 14, 2012
Subject - Upper rio Grande Water operations Model, Middle Rio Grande
Valley crop Acerage Consolidations and Depletion Computations
February 13, 2012 draft

Figure 32: Trees-Fruit Curve # 23

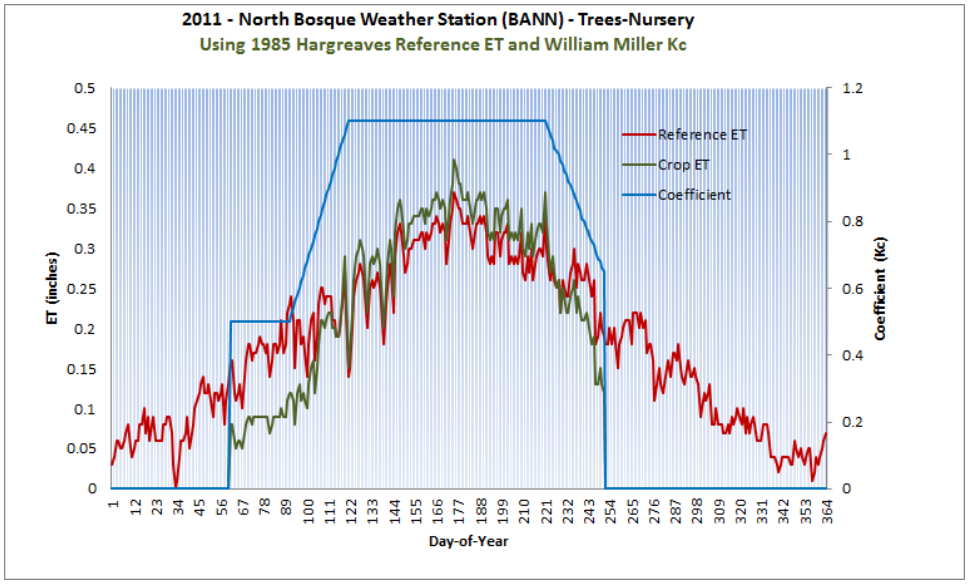


Crop coefficients Kc are based on Development Stages with Temp. in deg. F. and Lengths L in days

Crop	Cc	Start temp.	End temp.	L_ini	L_dev	L_mid	L_late	Kc_ini	Kc_dev	Kc_mid	Kc_end
Trees-Fru	23	50	45	20	70	83	45	.5	1.2	1.2	.83

Notes: Above from Bill Miller (William J. Miller Engineers, Inc) on May 14, 2012
Subject - Upper rio Grande Water operations Model, Middle Rio Grande
Valley crop Acerage Consolidations and Depletion Computations
February 13, 2012 draft

Figure 33: Trees-Nursery Curve # 24

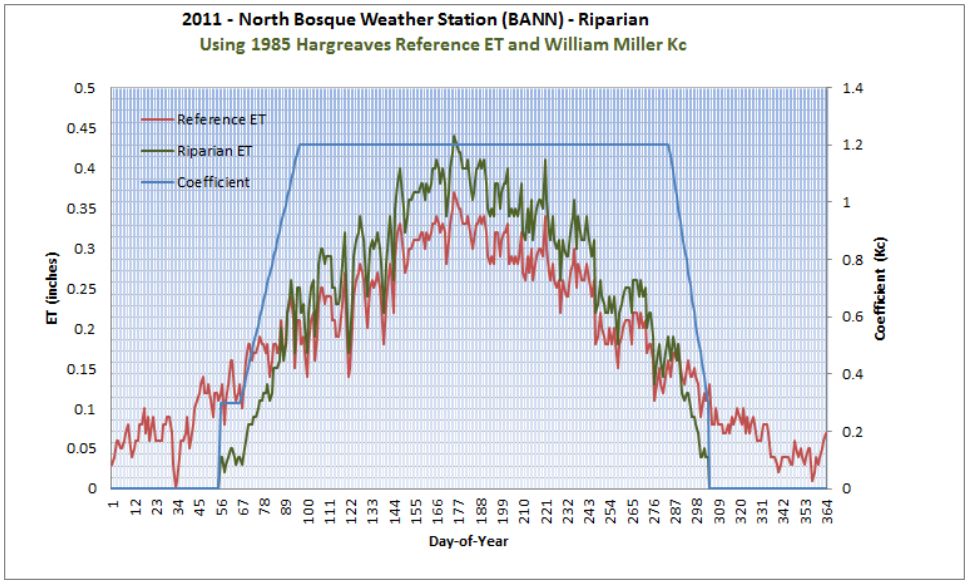


Crop coefficients Kc are based on Development Stages with Temp. in deg. F. and Lengths L in days

Crop	Cc	Start temp.	End temp.	L_ini	L_dev	L_mid	L_late	Kc_ini	Kc_dev	Kc_mid	Kc_end
Trees-Nur	24	50	45	30	30	100	30	.5	1.1	1.1	.65

Notes: Above from Bill Miller (William J. Miller Engineers, Inc) on May 14, 2012
Subject - Upper rio Grande Water operations Model, Middle Rio Grande
Valley crop Acerage Consolidations and Depletion Computations
February 13, 2012 draft

Figure 34: Riparian Curve # 25

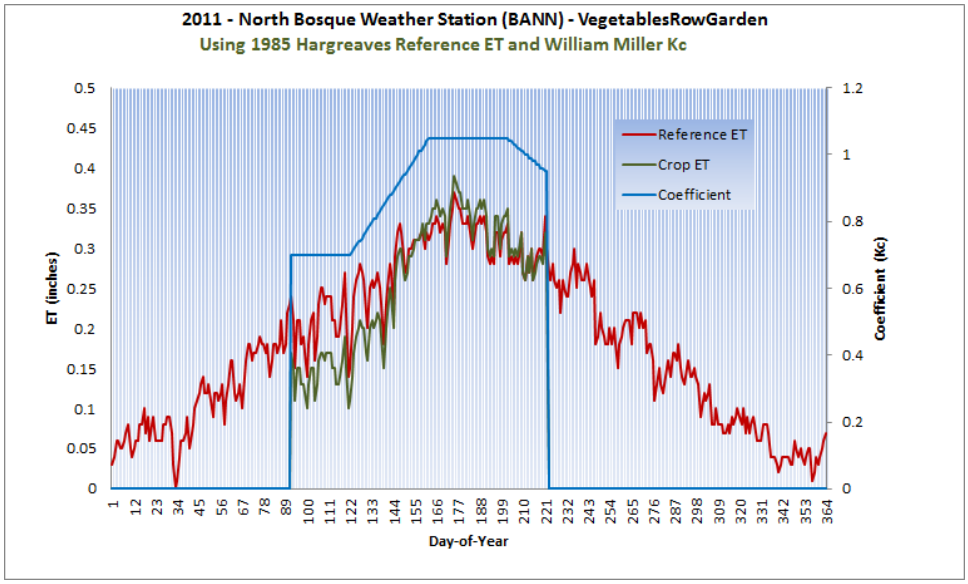


Crop coefficients Kc are based on Development Stages with Temp. in deg. F. and Lengths L in days

Crop	Cc	Start temp.	End temp.	L_ini	L_dev	L_mid	L_late	Kc_ini	Kc_dev	Kc_mid	Kc_end
Riparian	25	45	45	10	30	188	20	.3	1.2	1.2	.3

Notes: Above from Bill Miller (William J. Miller Engineers, Inc) on May 14, 2012
Subject - Upper rio Grande Water operations Model, Middle Rio Grande
Valley crop Acerage Consolidations and Depletion Computations
February 13, 2012 draft

Figure 35: VegetablesRowcropsGarden Curve # 26

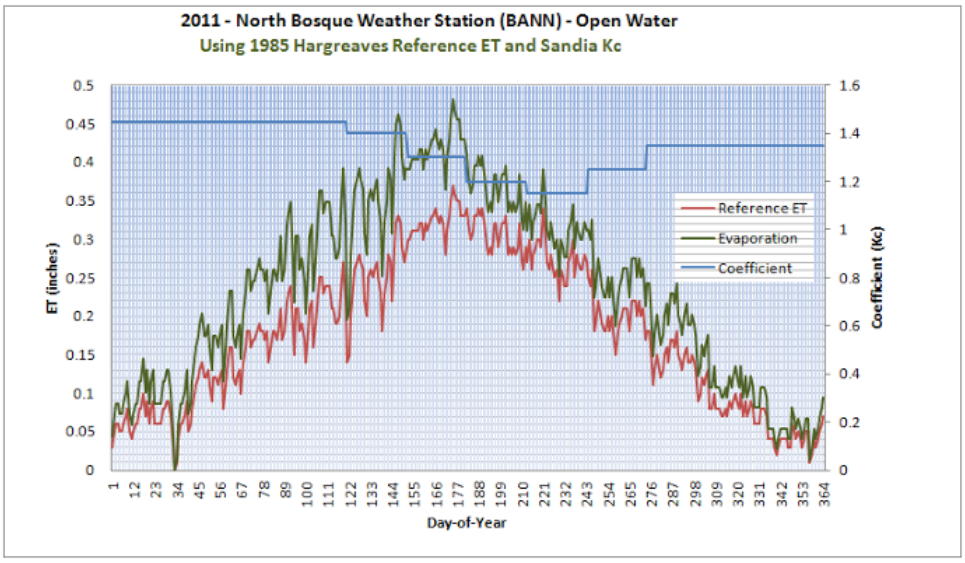


Crop coefficients Kc are based on Development Stages with Temp. in deg. F. and Lengths L in days

Crop	Cc	Start temp.	End temp.	L_ini	L_dev	L_mid	L_late	Kc_ini	Kc_dev	Kc_mid	Kc_end
VegRowGard	26	50	0	30	40	40	20	.7	1.05	1.05	.95

Notes: Above from Bill Miller (William J. Miller Engineers, Inc) on May 14, 2012
Subject - Upper Rio Grande Water operations Model, Middle Rio Grande
Valley crop Acerage Consolidations and Depletion Computations
February 13, 2012 draft

Figure 36: Open Water Curve # 1



Crop coefficients Kc are based on Development Stages with Temp. in deg. F. and Lengths L in days

Calculated Open Water Evaporation Coefficients by Month and Reservoir

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
El Vado				0.9	0.9	0.9	0.8	0.8	0.8	0.8		
Abiquiu				1.2	1.2	1.1	1.0	1.0	1.0	1.2		
Cochiti				1.3	1.2	1.2	1.1	1.1	1.2	1.3		
Elephant Butte	1.3	1.3	1.6	1.6	1.6	1.4	1.3	1.2	1,3	1.4	1.5	1.3
Caballo	1.4	1.2	1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.3	1.3	1.3

Notes: 1. Above from Jesse Roach of Sandia National Laboratories on March 13, 2012
Subject - Evaporation Calculations in the Upper Rio Grande Simulation
Model (URGSiM), page 20, table 2, March 13, 2012, draft.
Calculated from temperature and pan evaporation data measured
at five reservoirs in New Mexico between 1975 and 2006.

2. ET Toolbox uses monthly avegages of Cociti and Elephant Butte, with the
April value for Jan - Mar, and the Oct value for Nov and Dec:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.45	1.45	1.45	1.45	1.40	1.30	1.20	1.15	1.25	1.35	1.35	1.35

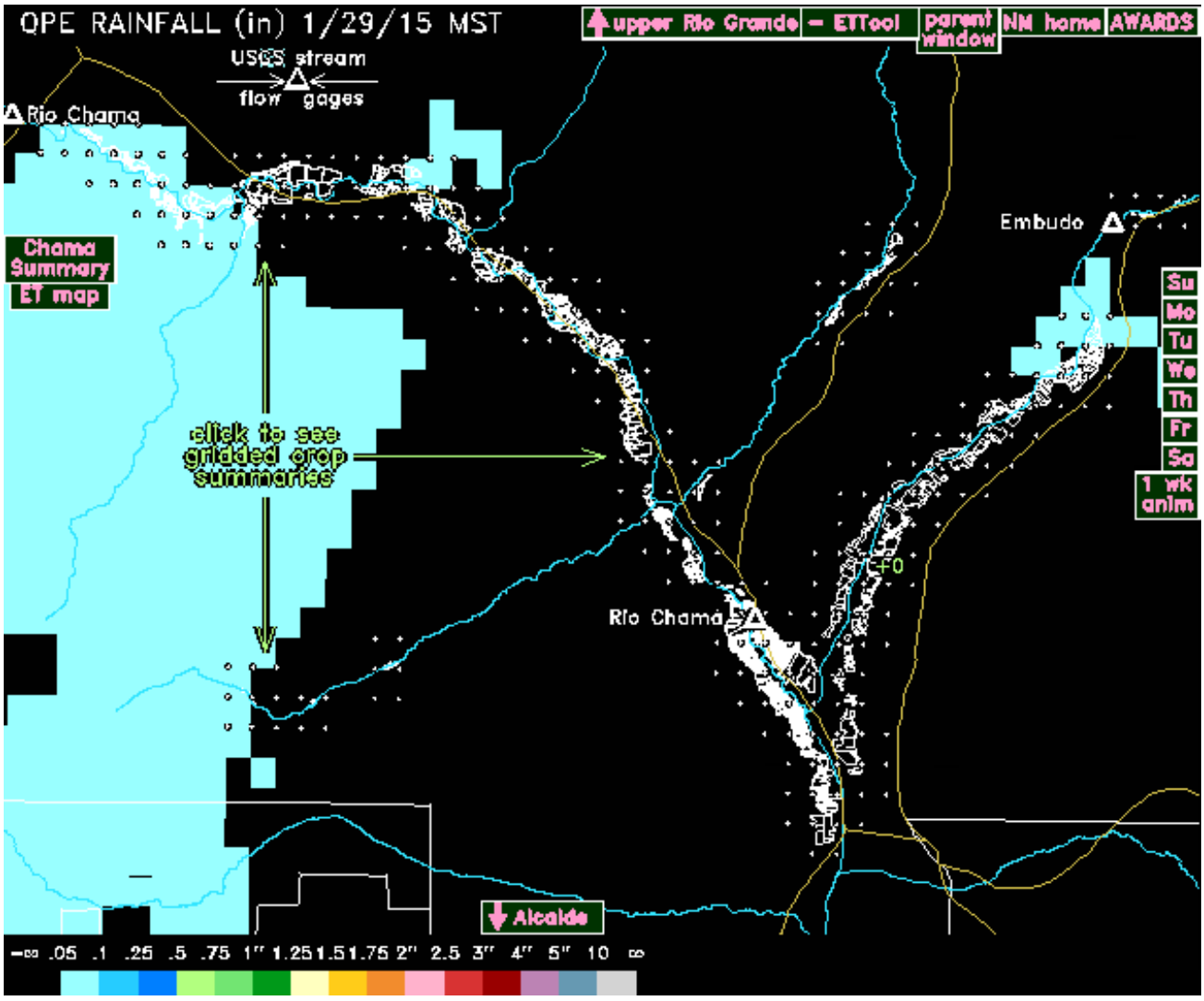


Figure 37: Rio Chama - ET Toolbox

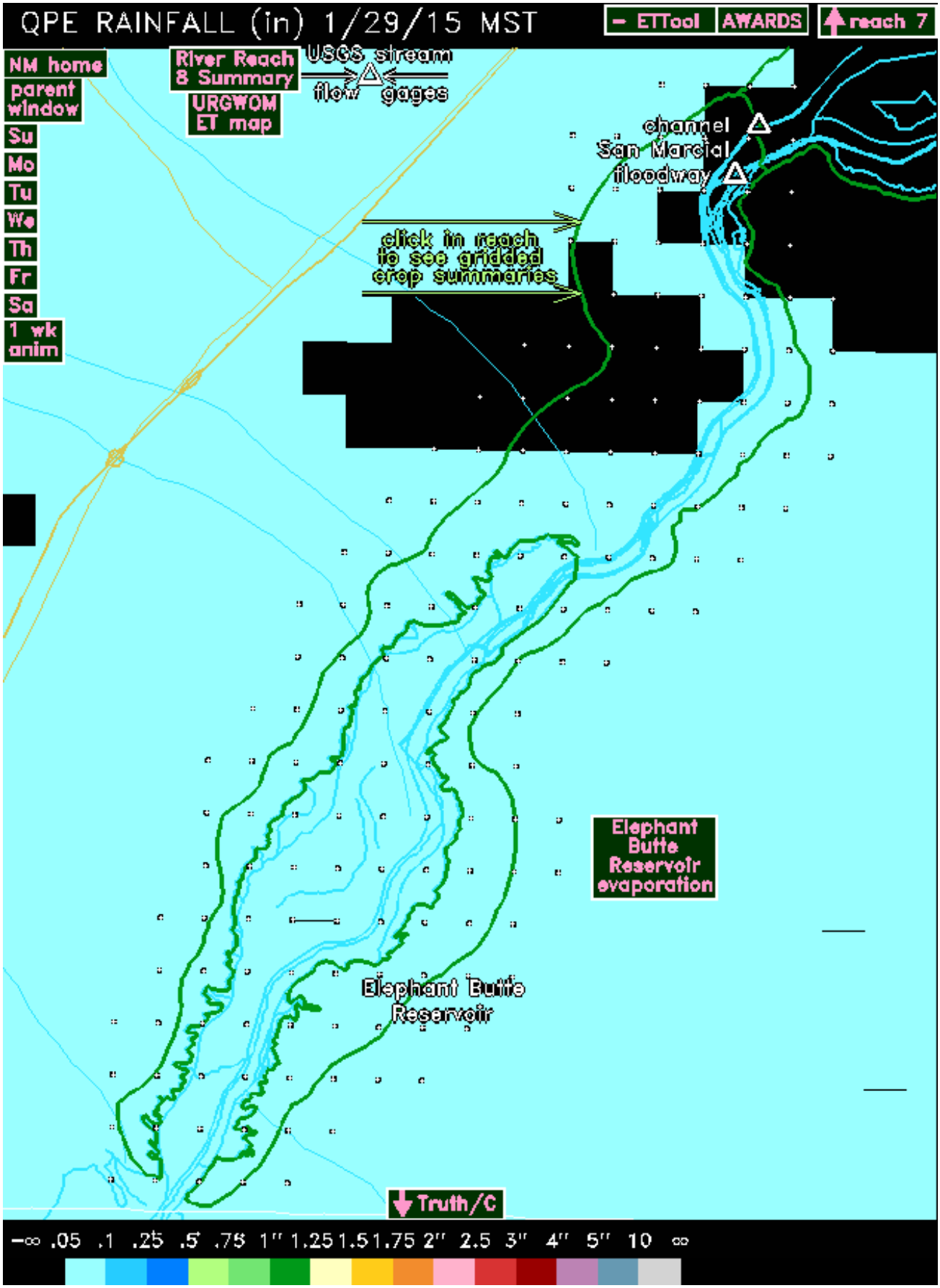


Figure 38: River Reach 8 - ET Toolbox

Figure 39: Elephant Butte Reservoir Evaporation Menu

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ET TOOLBOX CELL DETAILS

URGWOM Reach 8 (San Marcial to Elephant Butte)

Vegetation classification: MRGCD Ag. & IkonUSu Rip. (MRIU) (Except open water)

Cell number: 2292x1355

Weather station: North Elephant Butte Lake

Note: Final values are subject to change with updated weather data, which could occur multiple times during periods of local weather station data feed instability.

Last 7 and 7 Forecast Day's URGWOM Water Use in Acre-Feet (CFS)

Consumptive Use										Forecast						
						2014										
Crop	Acres	July 4	July 5	July 6	July 7	July 8	July 9	July 10	July 11	July 12	July 13	July 14	July 15	July 16	July 17
ElephWater	7423.0	194.6	205.2	169.6	186.4	177.4	168.9	185.6	197.9	197.9	197.9	197.9	197.9	191.8	185.6
Totals	7423.0	194.6	205.2	169.6	186.4	177.4	168.9	185.6	197.9	197.9	197.9	197.9	197.9	191.8	185.6
		(98.3)	(103.6)	(85.7)	(94.1)	(89.6)	(85.3)	(93.7)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(96.8)	(93.7)
Agricul.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Riparian	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Open Water	7423.0	194.6	205.2	169.6	186.4	177.4	168.9	185.6	197.9	197.9	197.9	197.9	197.9	191.8	185.6
		(98.3)	(103.6)	(85.7)	(94.1)	(89.6)	(85.3)	(93.7)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(96.8)	(93.7)
Urban	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
NEXRAD																
Rainfall Est.		68.0	105.2	37.1	0.0	61.9	43.3	0.0	86.6	55.7	55.7	266.0	365.0	6.2	259.8
		(34.4)	(53.1)	(18.7)	(0.0)	(31.2)	(21.9)	(0.0)	(43.7)	(28.1)	(28.1)	(134.3)	(184.3)	(3.1)	(131.2)
URGWOM																
Water Use		126.6	100.0	132.5	186.4	115.5	125.6	185.6	111.3	142.3	142.3	-68.0	-167.0	185.6	-74.2
		(63.9)	(50.5)	(66.9)	(94.1)	(58.3)	(63.4)	(93.7)	(56.2)	(71.9)	(71.9)	(-34.4)	(-84.4)	(93.7)	(-37.5)

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Figure 40: Elephant Butte Detail

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URGWOM Reach 8 (San Marcial to Elephant Butte)

Daily Evap. Rates for ElephWater Today is: July 11, 2014

Vegetation Classification: Open Water
Class Number: 91
Number of 1x1 km cells = 95 Number with ElephWater = 1
Weather station(s) used:
1) sbos South Bosque
2) elfb North Elephant Butte Lake
Plant and Terminate Dates, Hargreaves Reference (Ref.) ET, and
Open Water (OW) Coef. are averaged from above weather station(s)
Open Water (OW) Evap. = Ref. ET x Open Water Coef.
Total Water Use = Sum of cell water use
NEXRAD Rain = Sum of (cell rain x cell open water acres/12)
URGWOM Water Use = Total Water Use − NEXRAD Rain

Acres: 7423 Plant Date: Jan. 1 Termination Date: Dec. 31

Month (2014)	Day	Ref. ET (IN)	OW Coef.	OW Evap. (IN)	Total Water Use (AC−FT)	NEXRAD Rain (AC−FT)	URGWOM Water Use (AC−FT)	Acres
Mar.	23	0.14	1.45	0.21	0.09	0.00	0.09	0.00
Mar.	24	0.16	1.45	0.23	0.11	0.00	0.11	0.00
June	1	0.31	1.30	0.40	0.18	0.00	0.18	0.00
June	2	0.32	1.29	0.41	0.20	0.00	0.20	0.00
June	3	0.34	1.29	0.43	0.19	0.00	0.19	0.00
June	4	0.33	1.29	0.43	0.19	0.00	0.19	0.00
June	5	0.32	1.28	0.41	0.17	0.00	0.17	0.00
June	6	0.31	1.28	0.40	0.16	0.00	0.16	0.00
June	18	0.28	1.24	0.35	0.11	24.74	−24.63	0.00
June	19	0.28	1.24	0.34	0.08	0.00	0.08	0.00
June	20	0.30	1.23	0.36	0.08	0.00	0.08	0.00
June	21	0.29	1.23	0.36	0.08	12.37	−12.29	0.00
June	22	0.31	1.23	0.39	0.09	74.23	−74.14	0.00
June	23	0.31	1.22	0.37	0.08	0.00	0.08	0.00
June	24	0.31	1.22	0.37	0.08	0.00	0.08	0.00
June	25	0.31	1.22	0.38	0.08	0.00	0.08	0.00
June	26	0.32	1.21	0.39	0.09	0.00	0.09	0.00
June	27	0.30	1.21	0.36	0.08	0.00	0.08	0.00
June	28	0.30	1.21	0.36	0.08	0.00	0.08	0.00
June	29	0.31	1.20	0.37	0.07	0.00	0.07	0.00
June	30	0.32	1.20	0.39	0.08	55.67	−55.59	0.00
June Totals		9.09		11.34	3.93	364.96	−361.03	
July	1	0.30	1.20	0.35	0.08	37.12	−37.03	0.00
July	2	0.25	1.20	0.31	0.06	0.00	0.06	0.00
July	3	0.25	1.20	0.30	0.06	123.72	−123.66	0.00
July	4	0.27	1.19	0.32	194.61	68.04	126.57	8053.00
July	5	0.29	1.19	0.35	205.19	105.16	100.03	7943.00
July	6	0.25	1.19	0.30	169.61	37.12	132.49	7828.00
July	7	0.26	1.19	0.31	186.35	0.00	186.35	7711.00
July	8	0.26	1.19	0.32	177.38	61.86	115.52	7602.00
July	9	0.27	1.19	0.32	168.93	43.30	125.63	7508.00
July	10	0.27	1.18	0.32	185.58	0.00	185.58	7423.00
July Totals		2.67		3.18	1287.85	476.31	811.54	
Total To−Date		34.06		45.95	1305.96	2319.69	−1013.73	

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Figure 41: Elephant Butte Daily Evaporation Rates

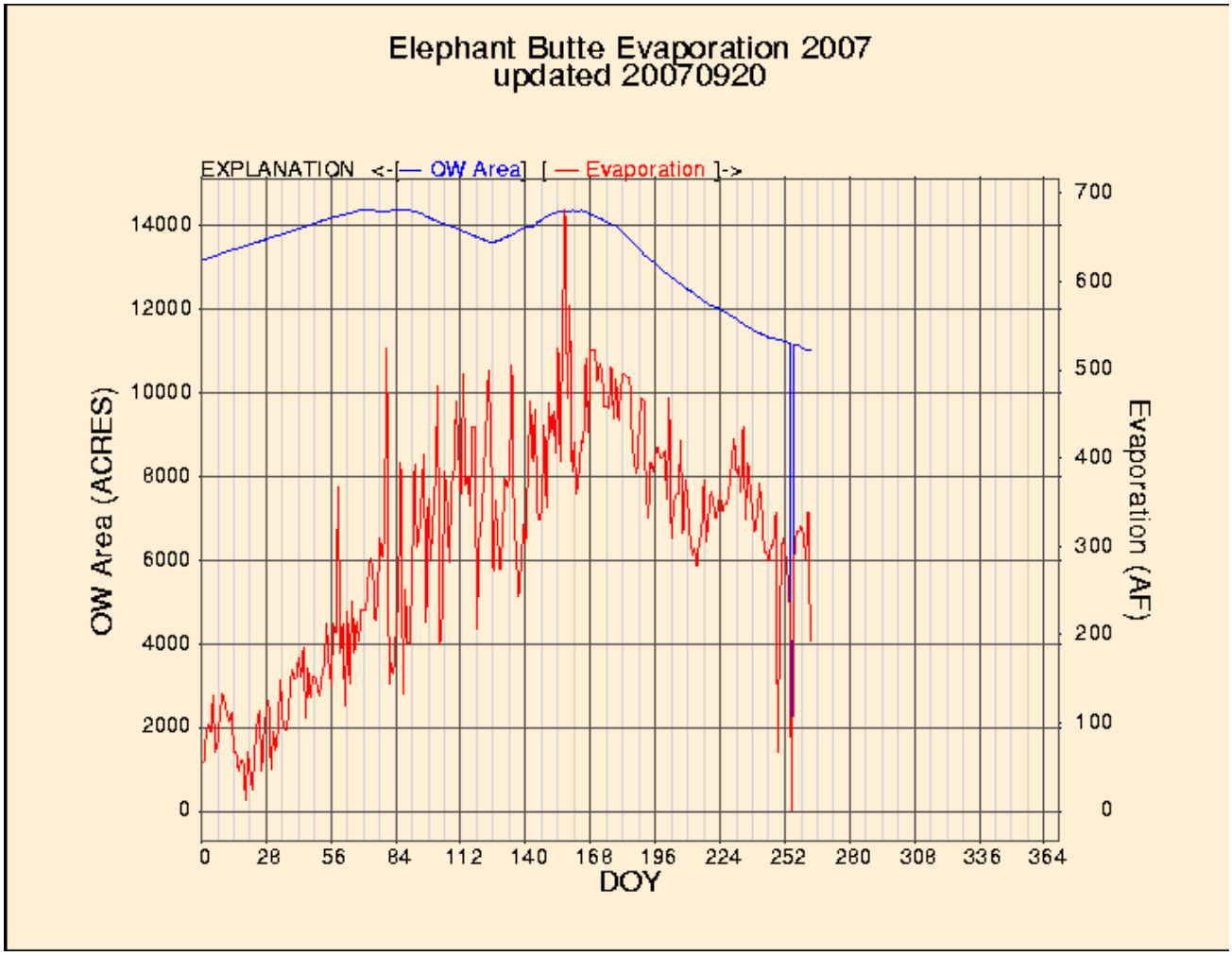

Figure 42: Elephant Butte Plot

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Feb 10, 15 15:11 **TOTPS.gage** Page 1/1

Gage Information − TOTPS − Total NCPPS NBYPS SBYPS FCRPS Pump Sta.

Year 2014

Month	Day	Time (mst)	NCPPS QR (cfs)	NBYPS QR (cfs)	SBYPS QR (cfs)	FCRPS QR (cfs)	TOTAL QR (cfs)	DAAVG QR (cfs)	NCPyr (acft)	NBYyr (acft)	SBYyr (acft)	FCRyr (acft)	Year (acft)
July	11	1730	0	0	29	0	29	28	0	3332	4847	0	8179
July	11	1700	0	0	30	0	30						
July	11	1630	0	0	29	0	29						
July	11	1600	0	0	29	0	29						
July	11	1530	0	0	28	0	28						
July	11	1500	0	0	28	0	28						
July	11	1430	0	0	28	0	28						
July	11	1400	0	0	29	0	29						
July	11	1330	0	0	29	0	29						
July	11	1300	0	0	29	0	29						
July	11	1230	0	0	29	0	29						
July	11	1200	0	0	29	0	29						
July	11	1130	0	0	30	0	30						
July	11	1100	0	0	29	0	29						
July	11	1030	0	0	30	0	30						
July	11	1000	0	0	30	0	30						
July	11	930	0	0	30	0	30						
July	11	900	0	0	30	0	30						
July	11	830	0	0	30	0	30						
July	11	800	0	0	30	0	30						
July	11	730	0	0	30	0	30						
July	11	700	0	0	30	0	30						
July	11	630	0	0	30	0	30						
July	11	600	0	0	30	0	30						
July	11	530	0	0	30	0	30						
July	11	500	0	0	26	0	26						
July	11	430	0	0	26	0	26						
July	11	400	0	0	26	0	26						
July	11	330	0	0	26	0	26						
July	11	300	0	0	26	0	26						
July	11	230	0	0	26	0	26						
July	11	200	0	0	26	0	26						
July	11	130	0	0	27	0	27						
July	11	100	0	0	27	0	27						
July	11	30	0	0	27	0	27						
July	11	0	0	0	27	0	27						
July	10	2330	0	0	27	0	27	26	0	3332	4791	0	8123
July	10	2300	0	0	27	0	27						
July	10	2230	0	0	28	0	28						
July	10	2200	0	0	28	0	28						
July	10	2130	0	0	28	0	28						
July	10	2100	0	0	28	0	28						
July	10	2030	0	0	28	0	28						
July	10	2000	0	0	28	0	28						
July	10	1930	0	0	28	0	28						
July	10	1900	0	0	28	0	28						
July	10	1830	0	0	28	0	28						
July	10	1800	0	0	29	0	29						
July	10	1730	0	0	29	0	29						
July	10	1700	0	0	20	0	20						
July	10	1630	0	0	25	0	25						
July	10	1600	0	0	25	0	25						
July	10	1530	0	0	25	0	25						

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Figure 43: Total Pumping Stations

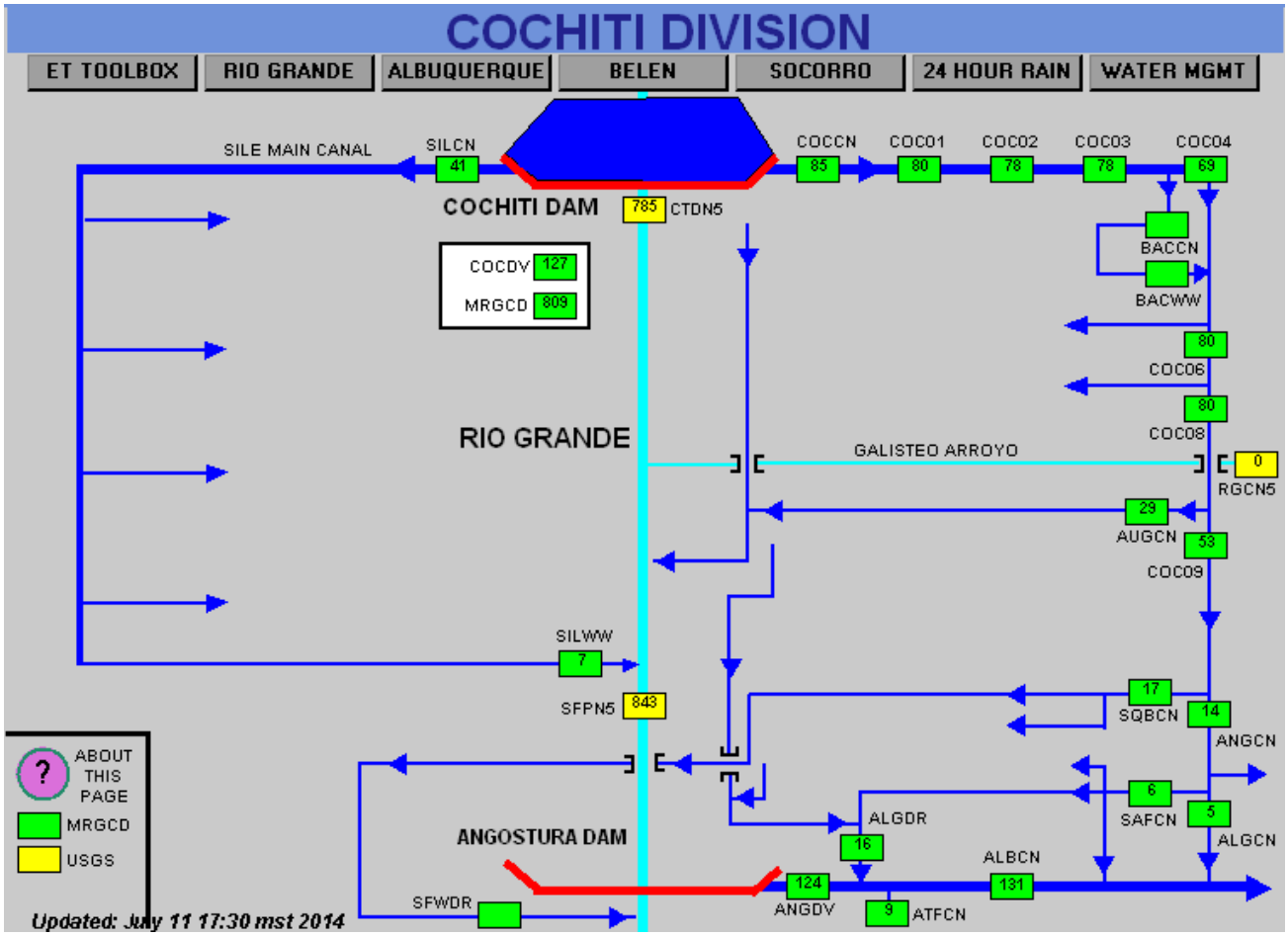

Figure 44: Cochiti Division Schematic

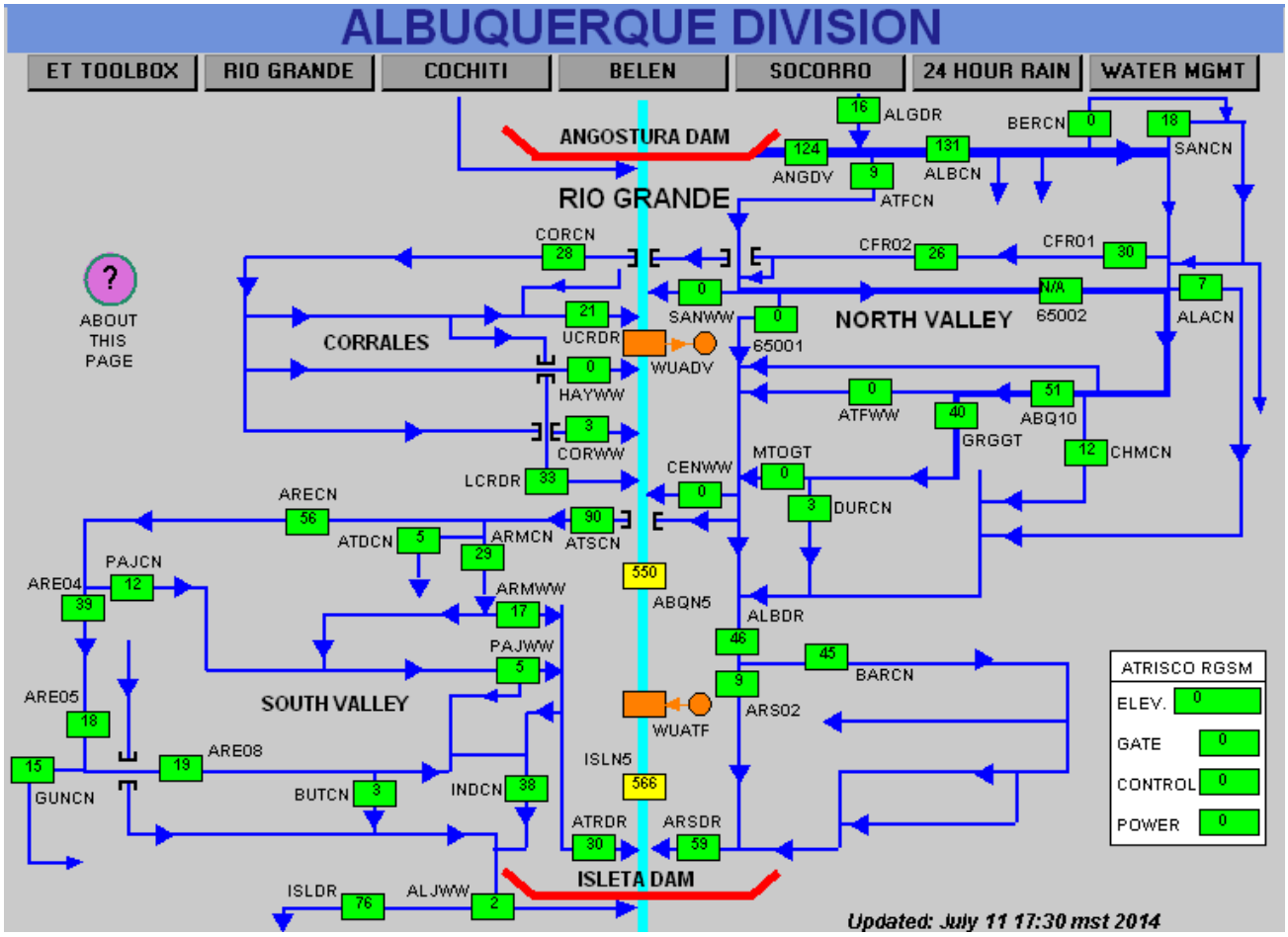

Figure 45: Albuquerque Division Schematic

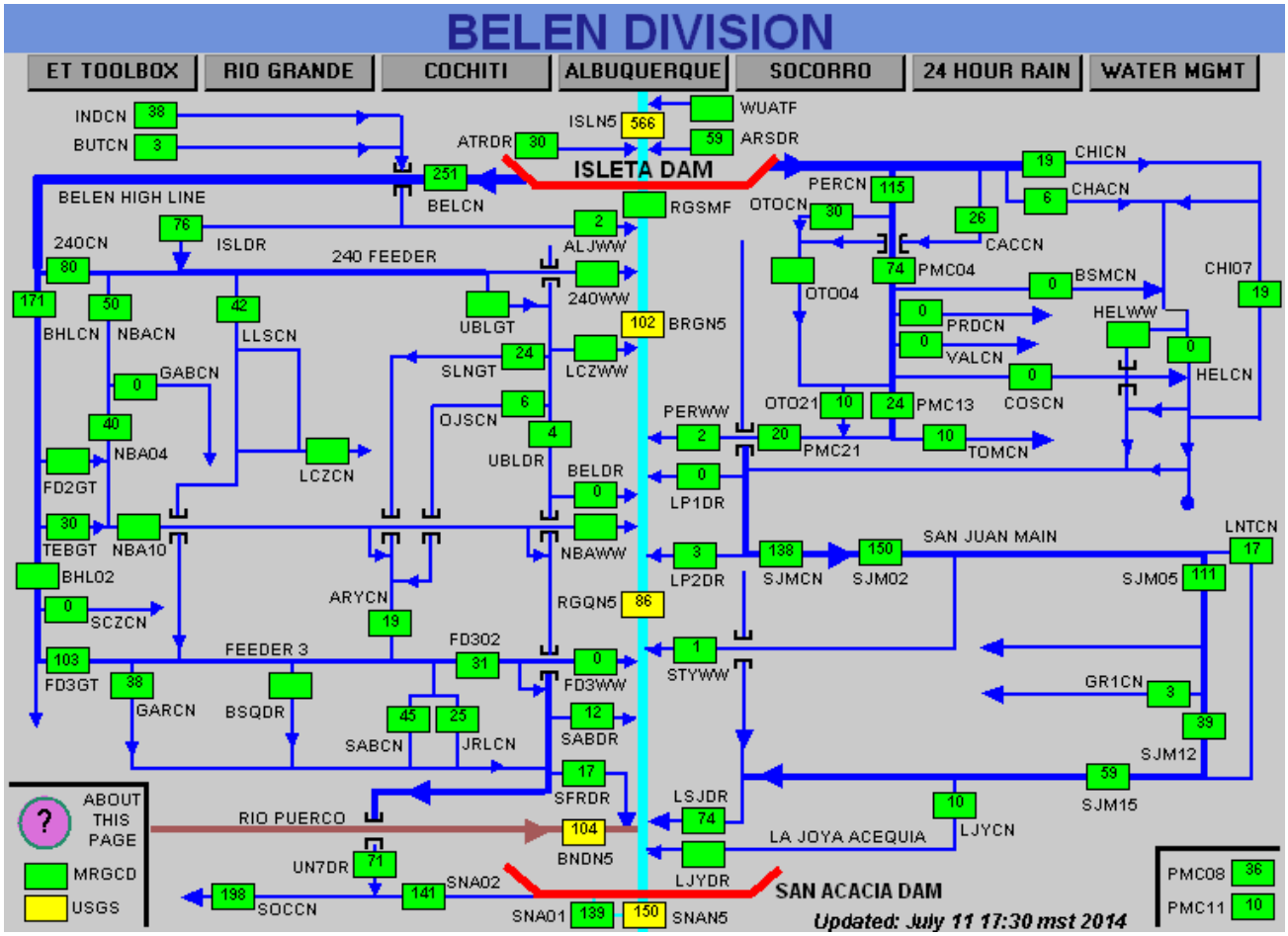

Figure 46: Belen Division Schematic

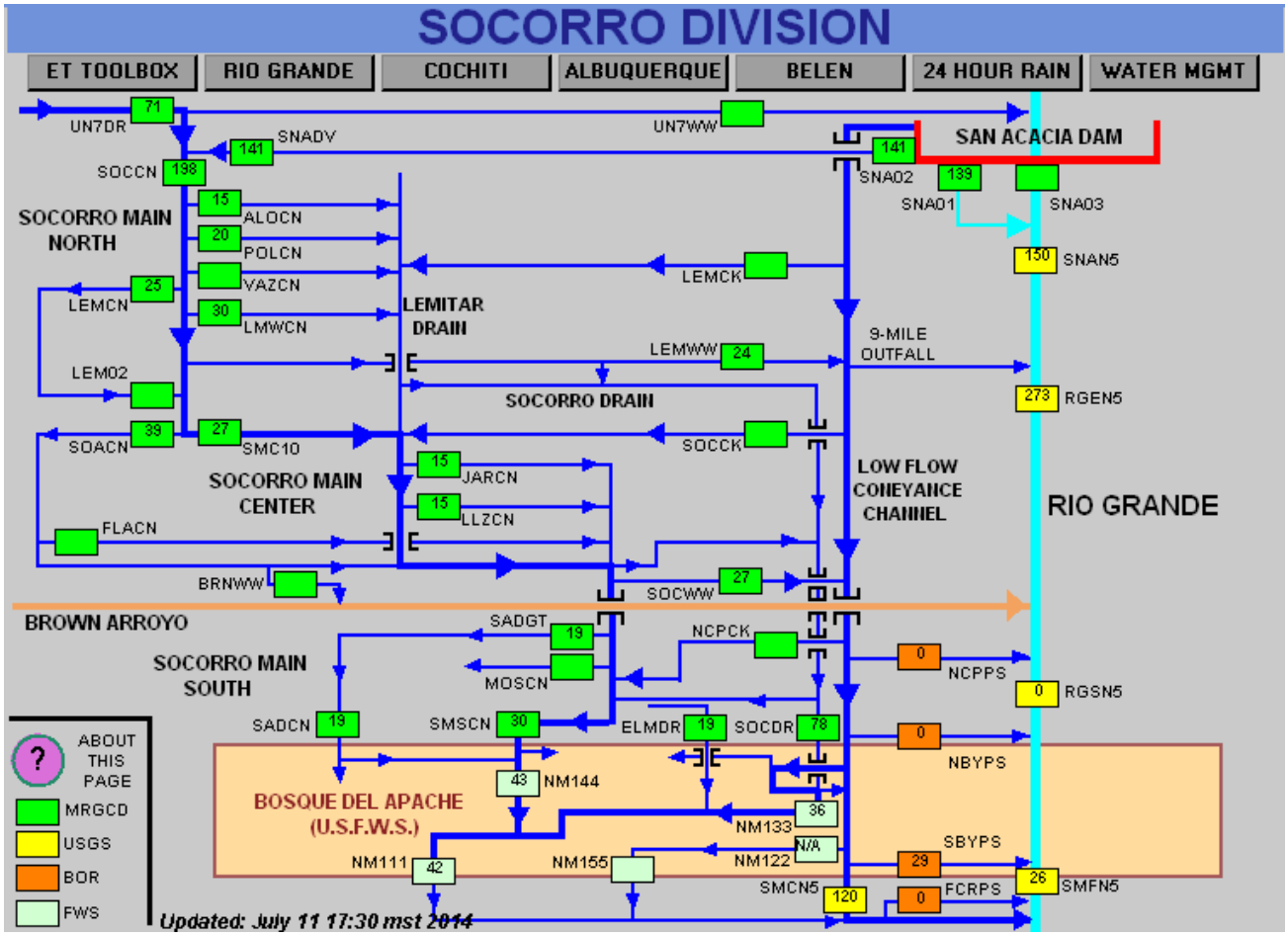

Figure 47: Socorro Division Schematic

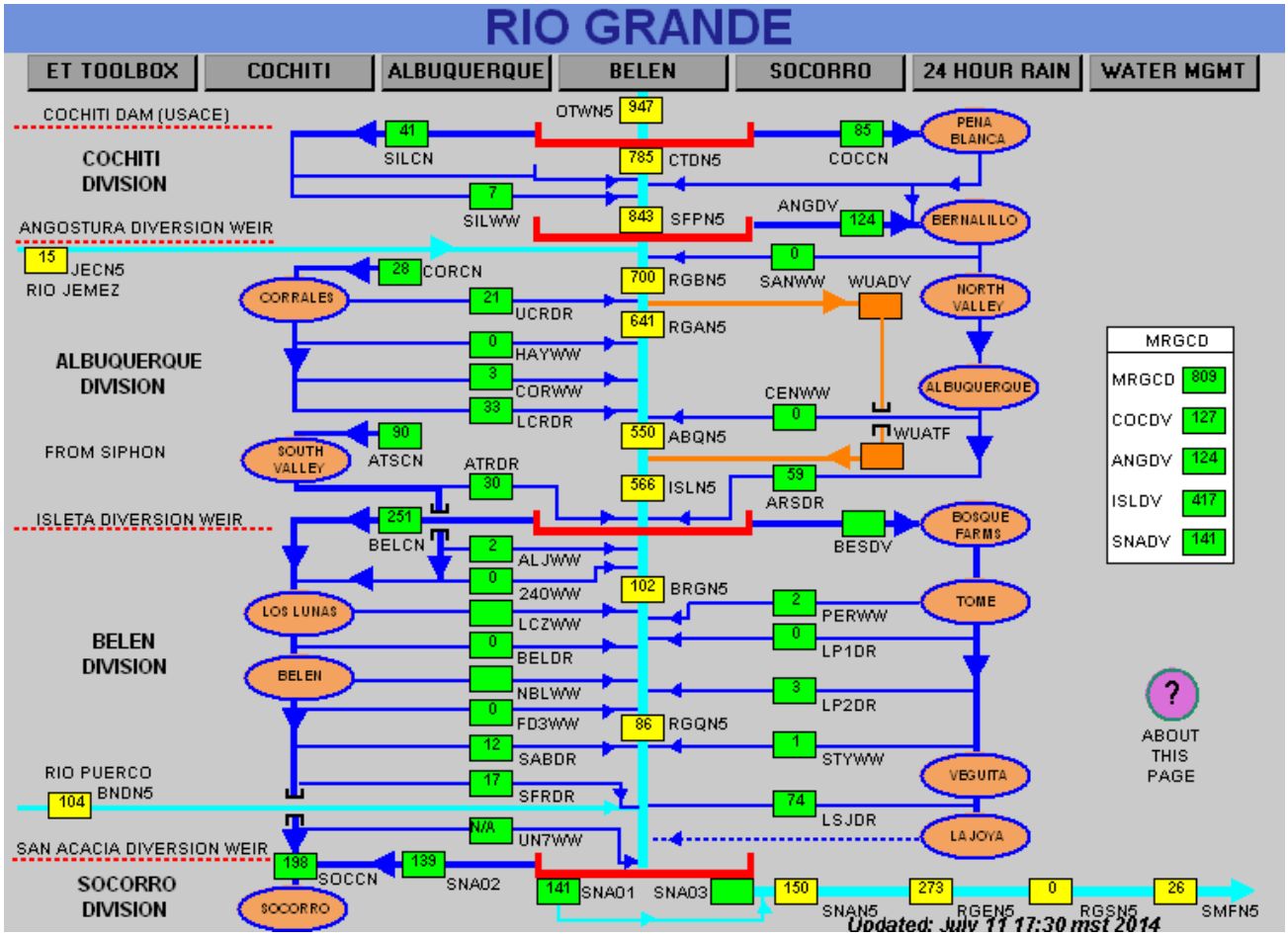

Figure 48: Rio Grande Schematic

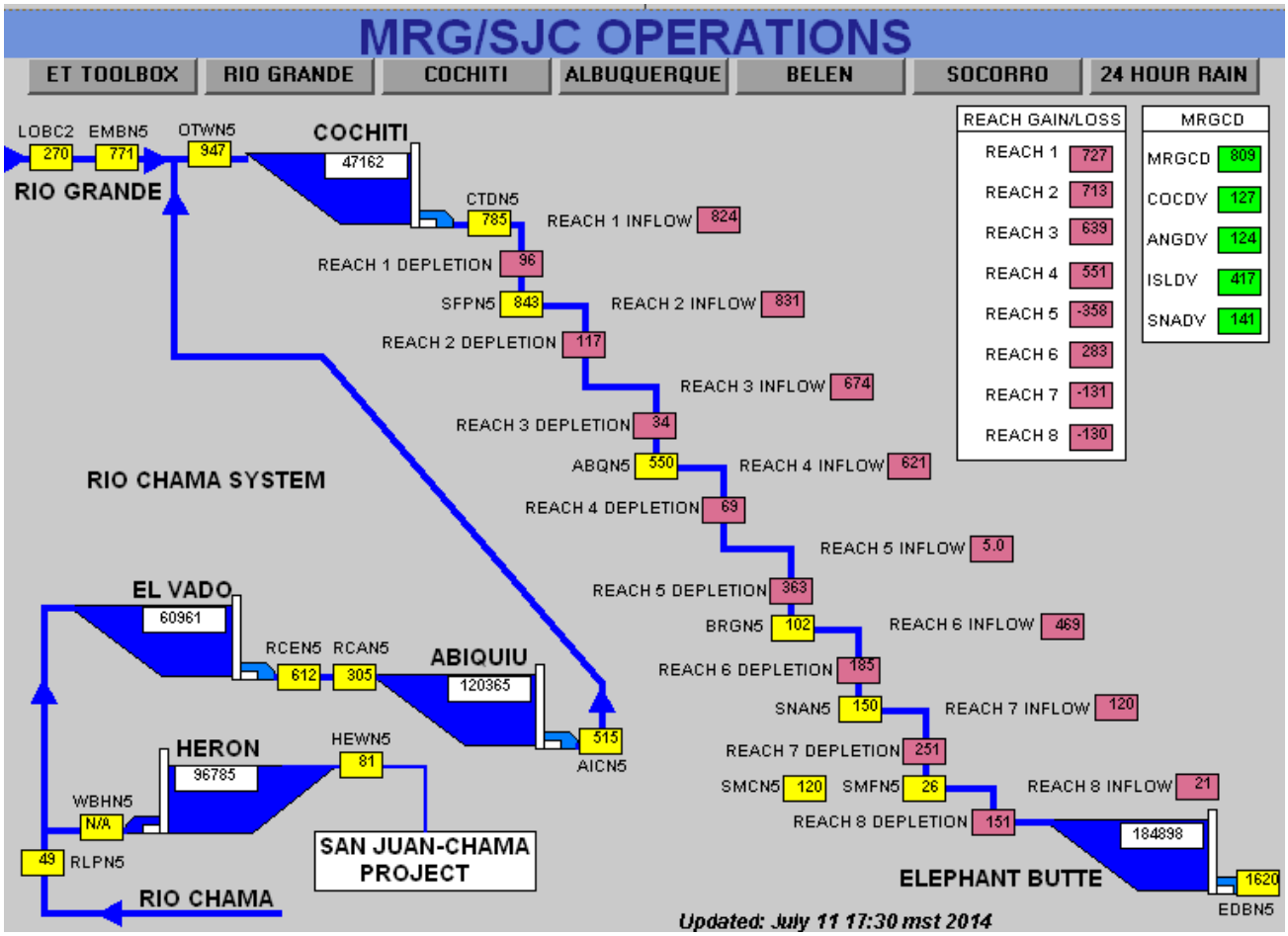

Figure 49: MRG/SJC Operations Schematic

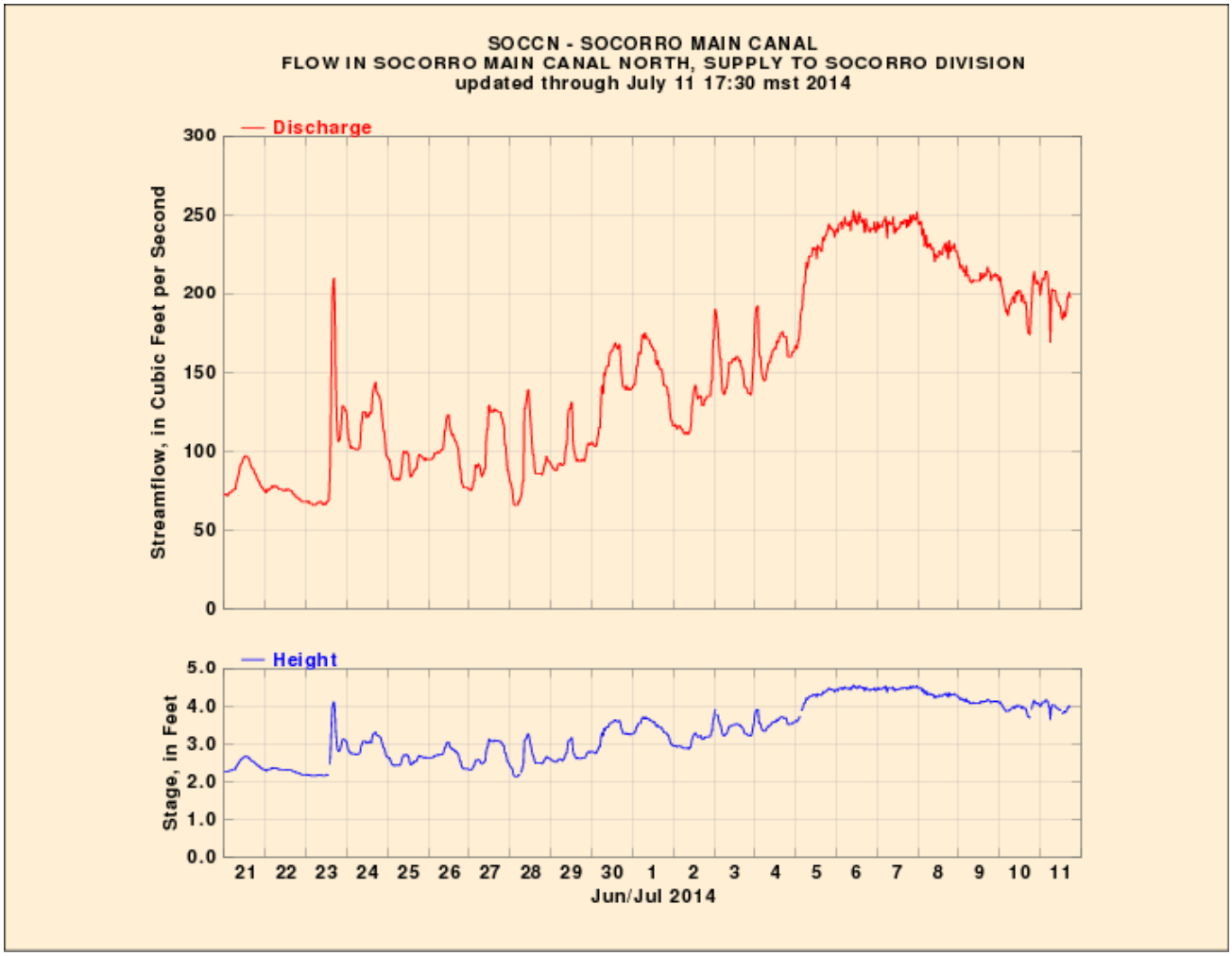

Figure 50: Socorro Main Canal Gage Heading

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Feb 10, 15 16:11 **SOCCN.gage** Page 1/1

Gage Information – SOCCN – SOCORRO MAIN CANAL
FLOW IN SOCORRO MAIN CANAL NORTH, SUPPLY TO SOCORRO DIVISION

Year 2014

Month	Day	Time (mst)	Height (HG ft)	Discharge (QR cfs)
July	11	1730	3.98	198
July	11	1700	4.01	201
July	11	1630	3.97	198
July	11	1600	3.97	198
July	11	1530	3.88	190
July	11	1500	3.84	186
July	11	1430	3.84	186
July	11	1400	3.87	189
July	11	1330	3.82	184
July	11	1300	3.82	184
July	11	1230	M	186
July	11	1200	3.90	192
July	11	1130	3.90	192
July	11	1100	3.91	193
July	11	1030	3.94	195
July	11	1000	3.94	195
July	11	930	3.96	197
July	11	900	4.01	202
July	11	830	4.02	202
July	11	800	4.02	202
July	11	730	4.02	202
July	11	700	4.03	203
July	11	630	3.98	198
July	11	600	3.64	169
July	11	530	3.96	197
July	11	500	4.01	201
July	11	430	4.12	211
July	11	400	4.16	214
July	11	330	4.16	214
July	11	300	4.16	214
July	11	230	4.10	209
July	11	200	4.10	209
July	11	130	4.11	210
July	11	100	4.06	206
July	11	30	4.03	203
July	11	0	3.99	199
July	10	2330	4.06	206
July	10	2300	4.06	206
July	10	2230	4.09	208
July	10	2200	4.08	208
July	10	2130	4.06	206
July	10	2100	4.11	210
July	10	2030	4.16	214
July	10	2000	4.12	211
July	10	1930	4.06	205
July	10	1900	3.93	194
July	10	1830	M	186
July	10	1800	3.70	174
July	10	1730	3.71	175
July	10	1700	3.71	175
July	10	1630	3.76	179

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Figure 51: Socorro Main Canal Heading

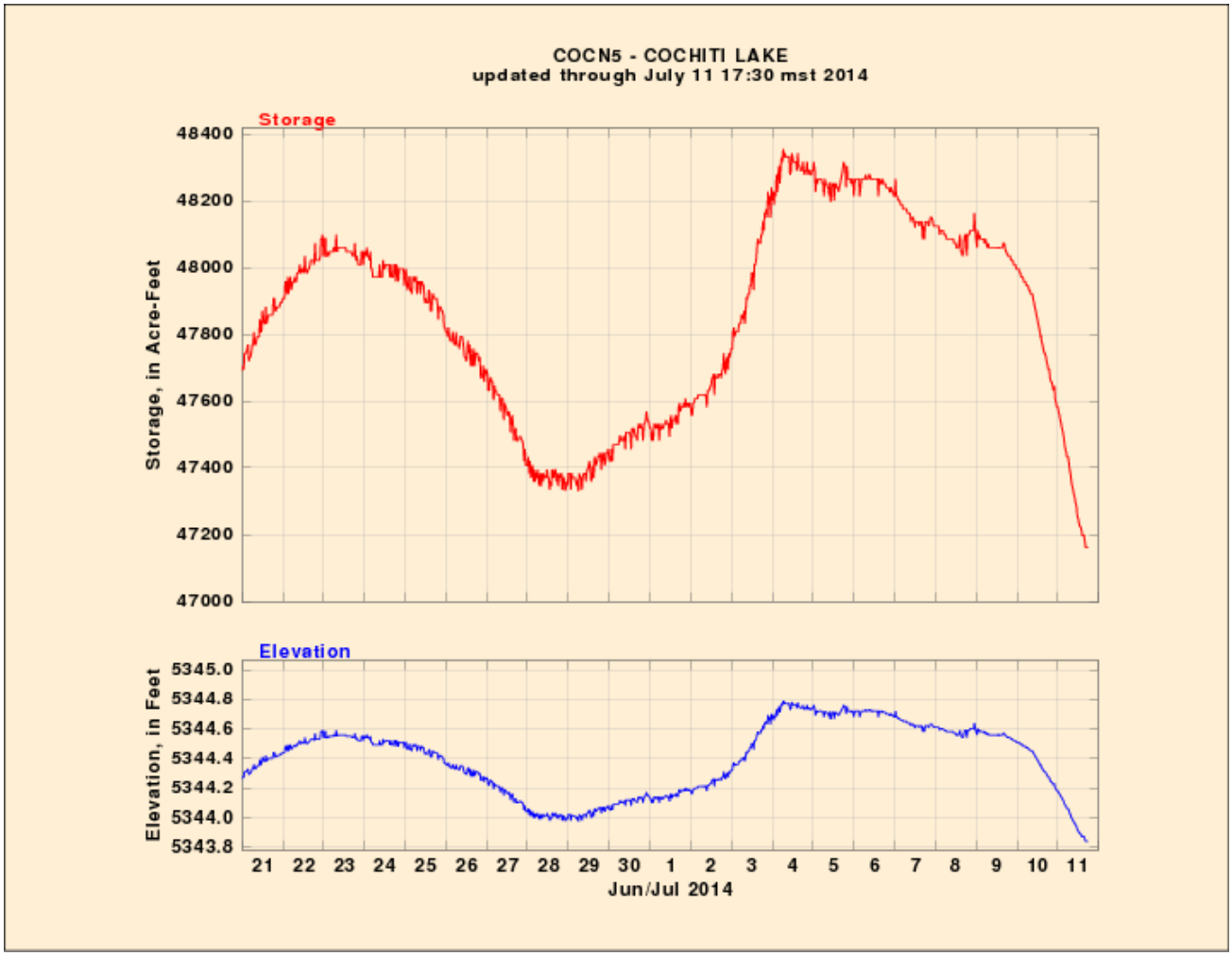

Figure 52: Cochiti Lake

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Jan 21, 15 16:04 **COCN5.gage** Page 1/1

Gage Information – COCN5 – COCHITI LAKE

Year 2014

Month	Day	Time (mst)	Storage (LS ac-ft)	Elevation (HP ft)
July	11	1730	47162	5343.84
July	11	1700	47162	5343.84
July	11	1630	47162	5343.84
July	11	1600	47175	5343.85
July	11	1530	47199	5343.87
July	11	1500	47199	5343.87
July	11	1430	47199	5343.87
July	11	1400	47211	5343.88
July	11	1330	47224	5343.89
July	11	1300	47224	5343.89
July	11	1230	47236	5343.90
July	11	1200	47248	5343.91
July	11	1130	47260	5343.92
July	11	1100	47285	5343.94
July	11	1030	47297	5343.95
July	11	1000	47309	5343.96
July	11	930	47322	5343.97
July	11	900	47334	5343.98
July	11	830	47346	5343.99
July	11	800	47359	5344.00
July	11	730	47383	5344.02
July	11	700	47395	5344.03
July	11	630	47420	5344.05
July	11	600	47433	5344.06
July	11	530	47433	5344.06
July	11	500	47445	5344.07
July	11	430	47457	5344.08
July	11	400	47469	5344.09
July	11	330	47494	5344.11
July	11	300	47507	5344.12
July	11	230	47519	5344.13
July	11	200	47532	5344.14
July	11	130	47544	5344.15
July	11	100	47557	5344.16
July	11	30	47569	5344.17
July	11	0	47582	5344.18
July	10	2330	47582	5344.18
July	10	2300	47594	5344.19
July	10	2230	47607	5344.20
July	10	2200	47644	5344.23
July	10	2130	47632	5344.22
July	10	2100	47644	5344.23
July	10	2030	47657	5344.24
July	10	2000	47657	5344.24
July	10	1930	47669	5344.25
July	10	1900	47694	5344.27
July	10	1830	47694	5344.27
July	10	1800	47706	5344.28
July	10	1730	47719	5344.29
July	10	1700	47731	5344.30
July	10	1630	47744	5344.31
July	10	1600	47744	5344.31
July	10	1530	47756	5344.32
July	10	1500	47769	5344.33
July	10	1430	47781	5344.34
July	10	1400	47794	5344.35
July	10	1330	47807	5344.36
July	10	1300	47820	5344.37
July	10	1230	47832	5344.38

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Figure 53: Cochiti Lake

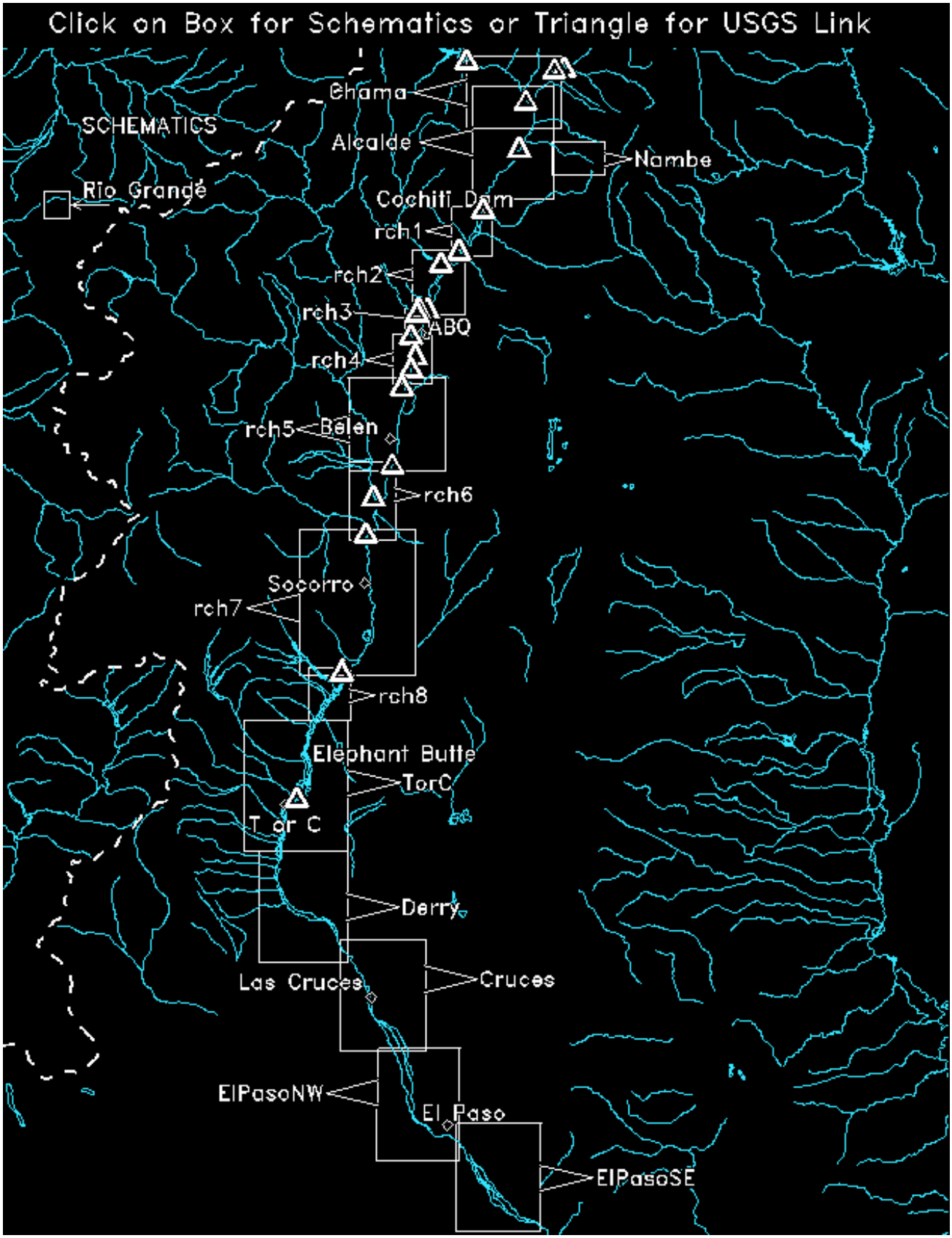

Figure 54: Stream Flow Products

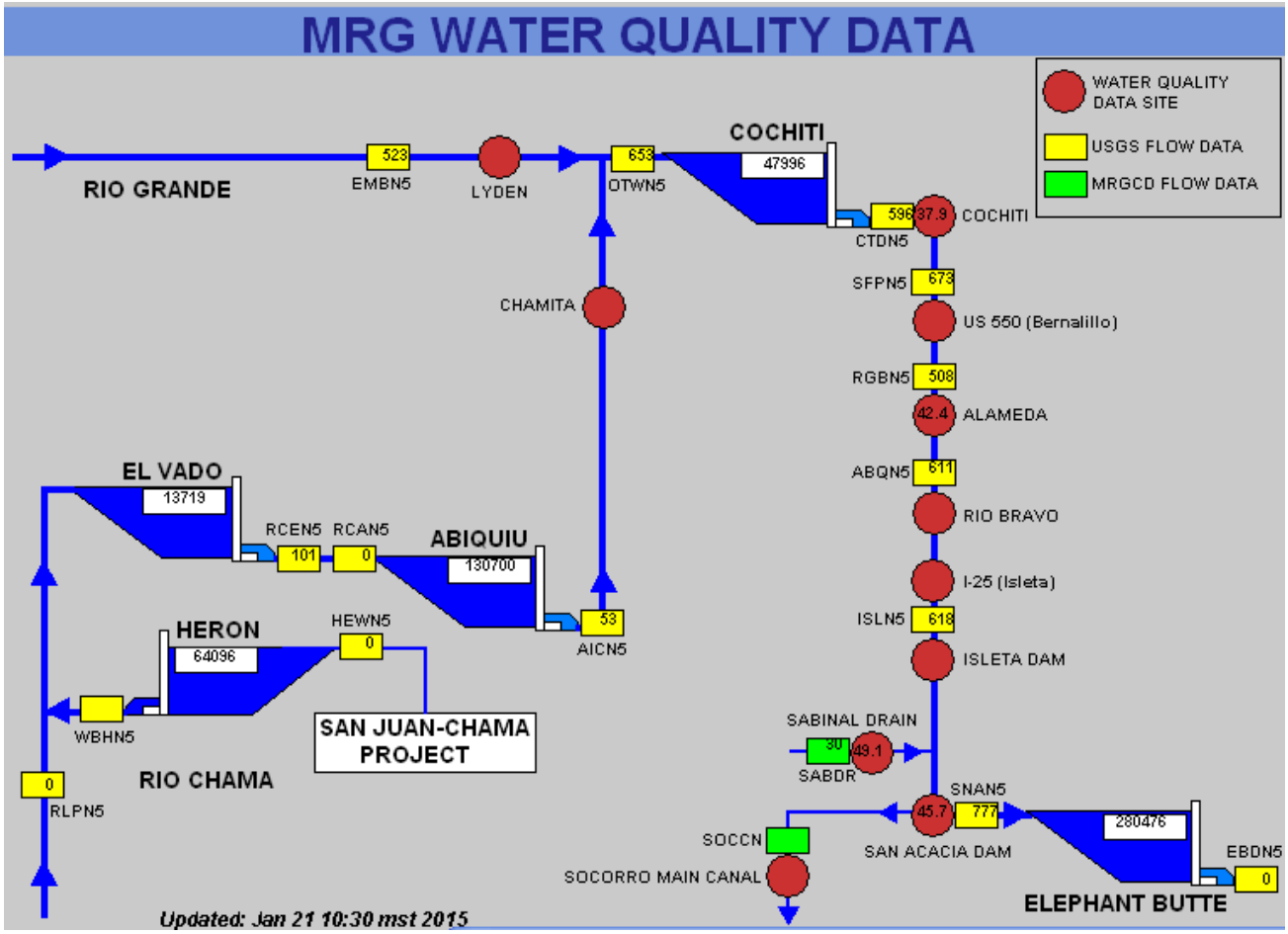

Figure 55: Water Quality Schematic

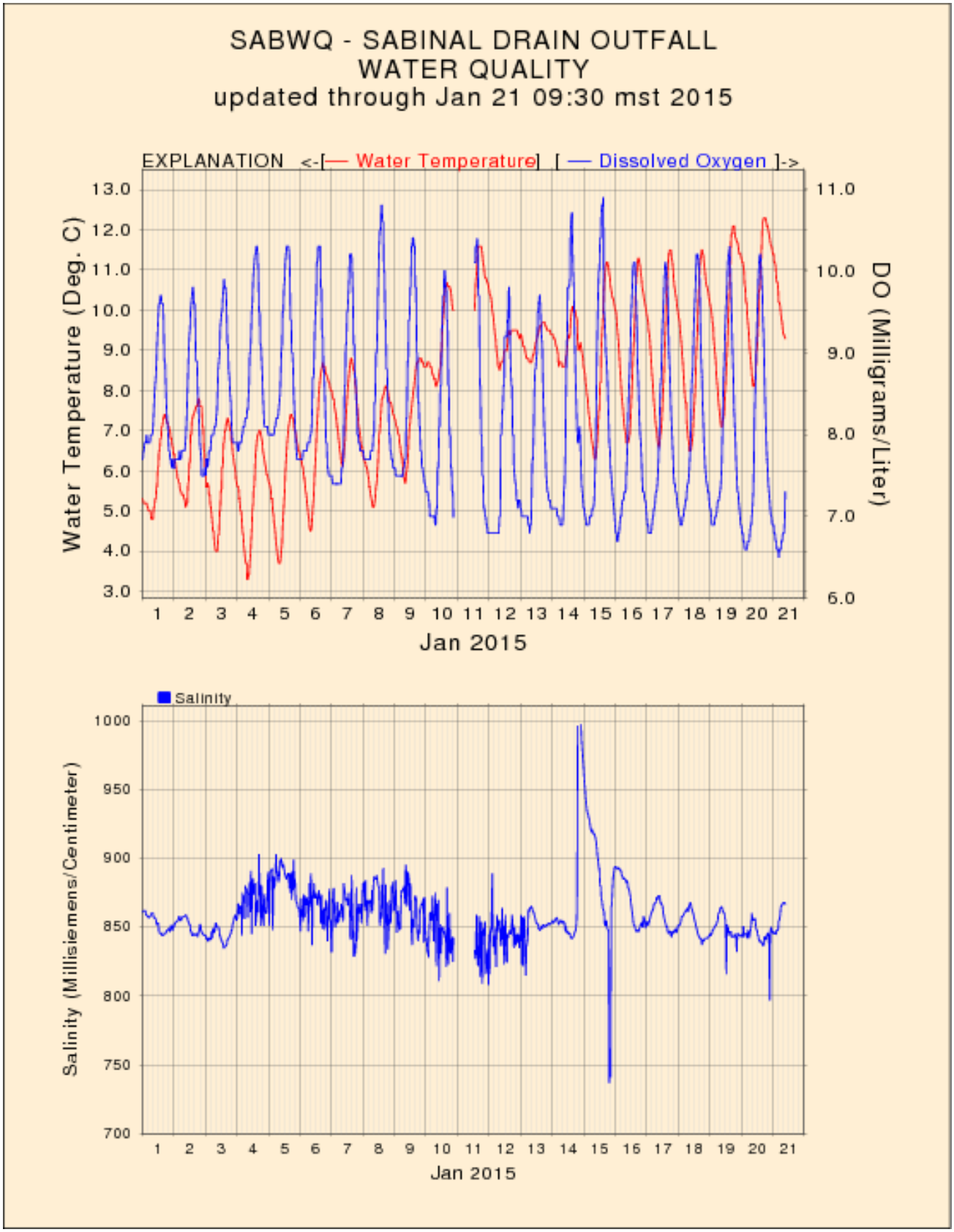

Figure 56: Sabinal Drain Outfall Plots

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Jan 21, 15 10:26 **SABWQ.gage** Page 1/1

Gage Information − SABWQ − SABINAL DRAIN OUTFALL
WATER QUALITY

Year 2015

Month	Day	Time (mst)	Water Temperature (deg. C)	(deg. F)	EC (ms/cm)	TDS (ppm)	DO (mg/l)	WaterHead (ft)	PH	Turb. (fnu)	DN (mg/l)	DP (mg/l)
Jan	21	0930	9.3	48.8	867	425	7.3	1.03	M	M	M	M
Jan	21	0900	9.3	48.8	868	425	7.0	1.03	M	M	M	M
Jan	21	0830	9.4	48.9	868	425	6.8	1.04	M	M	M	M
Jan	21	0800	9.4	48.9	868	425	6.8	1.04	M	M	M	M
Jan	21	0730	9.5	49.2	867	425	6.8	1.04	M	M	M	M
Jan	21	0700	9.7	49.4	867	425	6.7	1.04	M	M	M	M
Jan	21	0630	9.8	49.6	865	424	6.7	1.03	M	M	M	M
Jan	21	0600	9.9	49.8	865	424	6.6	1.03	M	M	M	M
Jan	21	0530	10.1	50.1	859	421	6.6	1.02	M	M	M	M
Jan	21	0500	10.2	50.4	855	419	6.6	1.00	M	M	M	M
Jan	21	0430	10.2	50.4	855	419	6.5	1.00	M	M	M	M
Jan	21	0400	10.5	50.9	848	416	6.6	0.97	M	M	M	M
Jan	21	0330	10.7	51.2	848	416	6.6	0.96	M	M	M	M
Jan	21	0300	10.7	51.2	848	416	6.6	0.96	M	M	M	M
Jan	21	0230	10.8	51.5	846	414	6.7	0.95	M	M	M	M
Jan	21	0200	11.1	52.0	845	414	6.7	0.96	M	M	M	M
Jan	21	0130	11.2	52.2	845	414	6.8	0.96	M	M	M	M
Jan	21	0100	11.2	52.2	845	414	6.8	0.96	M	M	M	M
Jan	21	0030	11.4	52.5	847	415	6.9	0.96	M	M	M	M
Jan	21	0000	11.4	52.6	846	415	6.9	0.96	M	M	M	M
Jan	20	2330	11.5	52.7	846	415	6.9	0.97	M	M	M	M
Jan	20	2300	11.6	52.8	849	416	7.0	0.97	M	M	M	M
Jan	20	2230	11.6	53.0	850	416	7.0	0.97	M	M	M	M
Jan	20	2200	11.7	53.1	846	415	7.1	0.98	M	M	M	M
Jan	20	2130	11.8	53.2	797	390	7.2	0.98	M	M	M	M
Jan	20	2100	11.9	53.4	840	411	7.3	0.98	M	M	M	M
Jan	20	2030	12.0	53.5	846	415	7.4	0.99	M	M	M	M
Jan	20	2000	12.1	53.7	845	414	7.6	0.99	M	M	M	M
Jan	20	1930	12.1	53.7	845	414	7.7	0.99	M	M	M	M
Jan	20	1900	12.2	54.0	841	412	7.9	1.00	M	M	M	M
Jan	20	1830	12.3	54.1	841	412	8.2	1.00	M	M	M	M
Jan	20	1800	12.3	54.2	843	413	8.4	1.00	M	M	M	M
Jan	20	1730	12.3	54.2	843	413	8.8	1.00	M	M	M	M
Jan	20	1700	12.3	54.2	837	410	9.2	1.00	M	M	M	M
Jan	20	1630	12.2	53.9	837	410	9.4	1.00	M	M	M	M
Jan	20	1600	12.2	53.9	837	410	9.7	1.00	M	M	M	M
Jan	20	1530	11.6	52.8	839	411	9.9	0.99	M	M	M	M
Jan	20	1500	11.2	52.2	840	412	10.1	0.99	M	M	M	M
Jan	20	1430	10.9	51.6	839	411	10.2	0.99	M	M	M	M
Jan	20	1400	10.5	51.0	840	412	10.2	0.99	M	M	M	M
Jan	20	1330	10.5	51.0	840	412	10.1	0.99	M	M	M	M
Jan	20	1300	9.7	49.5	844	414	9.9	0.98	M	M	M	M
Jan	20	1230	9.4	48.9	844	414	9.7	0.98	M	M	M	M
Jan	20	1200	9.0	48.3	848	416	9.4	0.98	M	M	M	M
Jan	20	1130	9.0	48.3	848	416	9.1	0.98	M	M	M	M
Jan	20	1100	8.5	47.3	850	417	8.8	0.98	M	M	M	M
Jan	20	1030	8.3	47.0	856	419	8.5	0.98	M	M	M	M
Jan	20	1000	8.2	46.8	856	420	8.2	0.98	M	M	M	M
Jan	20	0930	8.1	46.7	856	420	7.7	0.98	M	M	M	M
Jan	20	0900	8.1	46.6	855	419	7.3	0.98	M	M	M	M
Jan	20	0830	8.2	46.8	856	420	7.1	0.98	M	M	M	M
Jan	20	0800	8.4	47.1	860	421	7.0	0.98	M	M	M	M
Jan	20	0730	8.6	47.5	852	417	6.9	0.98	M	M	M	M
Jan	20	0700	8.8	47.8	848	415	6.9	0.98	M	M	M	M
Jan	20	0630	9.0	48.2	846	415	6.8	0.98	M	M	M	M
Jan	20	0600	9.2	48.6	842	413	6.7	0.98	M	M	M	M
Jan	20	0530	9.5	49.1	846	414	6.7	0.99	M	M	M	M
Jan	20	0500	9.7	49.5	848	415	6.7	0.99	M	M	M	M
Jan	20	0430	9.9	49.9	842	412	6.6	0.99	M	M	M	M

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Figure 57: Sabinal Drain Outfall Table

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R	150	153	156	161	163	164	167	401	402	403	409	413
0601 1	0.314	0.315	0.321	0.302	0.315	0.318	0.314	0.256	0.250	0.255	0.266	0.240
0602 1	0.340	0.340	0.337	0.316	0.340	0.340	0.330	0.270	0.271	0.270	0.291	0.240
0603 1	0.360	0.360	0.361	0.338	0.360	0.360	0.353	0.280	0.292	0.280	0.307	0.240
0604 1	0.354	0.355	0.361	0.338	0.355	0.358	0.346	0.280	0.298	0.280	0.299	0.240
0605 1	0.345	0.345	0.350	0.316	0.346	0.348	0.337	0.276	0.295	0.276	0.291	0.240
0606 1	0.330	0.329	0.337	0.316	0.330	0.337	0.327	0.266	0.289	0.266	0.266	0.240
0607 1	0.310	0.310	0.308	0.287	0.310	0.310	0.314	0.250	0.273	0.250	0.266	0.240
0608 1	0.255	0.255	0.260	0.244	0.255	0.258	0.250	0.206	0.234	0.206	0.218	0.240
0609 1	0.295	0.295	0.299	0.280	0.295	0.298	0.295	0.236	0.271	0.235	0.250	0.240
0610 1	0.320	0.320	0.321	0.302	0.320	0.320	0.314	0.260	0.295	0.260	0.266	0.240
0611 1	0.320	0.320	0.321	0.302	0.320	0.320	0.314	0.260	0.298	0.260	0.266	0.240
0612 1	0.304	0.305	0.308	0.287	0.306	0.308	0.314	0.246	0.288	0.246	0.258	0.240
0613 1	0.284	0.285	0.289	0.273	0.285	0.288	0.282	0.226	0.267	0.226	0.234	0.240
0614 1	0.314	0.315	0.321	0.302	0.315	0.318	0.314	0.256	0.301	0.255	0.266	0.240
0615 1	0.314	0.315	0.321	0.302	0.315	0.318	0.314	0.256	0.301	0.255	0.266	0.240
0616 1	0.340	0.340	0.337	0.316	0.340	0.340	0.330	0.270	0.317	0.270	0.291	0.240
0617 1	0.304	0.305	0.308	0.287	0.306	0.308	0.314	0.246	0.293	0.246	0.258	0.240
0618 1	0.295	0.295	0.299	0.280	0.295	0.298	0.295	0.236	0.285	0.235	0.250	0.240
0619 1	0.304	0.305	0.308	0.287	0.306	0.308	0.314	0.246	0.297	0.246	0.258	0.240
0620 1	0.320	0.320	0.321	0.302	0.320	0.320	0.314	0.260	0.311	0.260	0.266	0.240
0621 1	0.320	0.320	0.321	0.302	0.320	0.320	0.314	0.260	0.311	0.260	0.266	0.240
0622 1	0.330	0.329	0.337	0.316	0.330	0.337	0.327	0.266	0.317	0.266	0.266	0.240
0623 1	0.314	0.315	0.321	0.302	0.315	0.318	0.314	0.256	0.307	0.255	0.266	0.240
0624 1	0.320	0.320	0.321	0.302	0.320	0.320	0.314	0.260	0.311	0.260	0.266	0.240
0625 1	0.340	0.340	0.337	0.316	0.340	0.340	0.330	0.270	0.321	0.270	0.291	0.240
0626 1	0.345	0.345	0.350	0.316	0.346	0.348	0.337	0.276	0.328	0.276	0.291	0.240
0627 1	0.284	0.285	0.289	0.273	0.285	0.288	0.282	0.226	0.274	0.226	0.234	0.240
0628 1	0.340	0.340	0.337	0.316	0.340	0.340	0.330	0.270	0.321	0.270	0.291	0.240
0629 1	0.349	0.349	0.361	0.331	0.350	0.356	0.346	0.276	0.335	0.276	0.291	0.240
0630 1	0.354	0.355	0.361	0.338	0.355	0.358	0.346	0.280	0.338	0.280	0.299	0.240
0701 1	0.295	0.295	0.299	0.280	0.295	0.298	0.295	0.236	0.285	0.235	0.250	0.240
0702 1	0.280	0.280	0.277	0.266	0.280	0.281	0.276	0.220	0.260	0.220	0.234	0.240
0703 1	0.270	0.269	0.277	0.266	0.270	0.277	0.273	0.216	0.256	0.216	0.226	0.240
0704 1	0.290	0.290	0.289	0.273	0.289	0.290	0.282	0.230	0.279	0.230	0.250	0.240
0705 1	0.295	0.295	0.299	0.280	0.295	0.298	0.295	0.236	0.285	0.235	0.250	0.240
0706 1	0.305	0.305	0.299	0.280	0.305	0.302	0.305	0.244	0.291	0.244	0.266	0.240
0707 1	0.300	0.300	0.299	0.280	0.300	0.300	0.305	0.240	0.289	0.240	0.258	0.240
0708 1	0.284	0.285	0.289	0.273	0.285	0.288	0.282	0.226	0.274	0.226	0.234	0.240
0709 1	0.284	0.285	0.289	0.273	0.285	0.288	0.282	0.226	0.274	0.226	0.234	0.240
0710 1	0.304	0.305	0.308	0.287	0.306	0.308	0.314	0.246	0.297	0.246	0.258	0.240
0711 1	0.304	0.305	0.308	0.287	0.306	0.308	0.314	0.246	0.297	0.246	0.258	0.240
0712 1	0.310	0.310	0.308	0.287	0.310	0.310	0.314	0.250	0.299	0.250	0.266	0.240
0713 1	0.304	0.305	0.308	0.287	0.306	0.308	0.314	0.246	0.297	0.246	0.258	0.240
0714 1	0.304	0.305	0.308	0.287	0.306	0.308	0.314	0.246	0.297	0.246	0.258	0.240
0715 1	0.295	0.295	0.299	0.280	0.295	0.298	0.295	0.236	0.285	0.235	0.234	0.240
0716 1	0.299	0.300	0.308	0.287	0.301	0.307	0.305	0.241	0.293	0.241	0.234	0.240
0717 1	0.295	0.295	0.299	0.280	0.295	0.298	0.295	0.236	0.285	0.235	0.234	0.240

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Figure 58: URGWOM Consumptive Use - Reach 1

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	1	2	3	4	5	6	7	8
0601	100.4	107.8	44.3	95.9	372.8	208.5	329.8	69.5
0602	106.9	133.9	46.3	102.6	389.3	213.9	332.5	69.5
0603	112.8	146.8	49.8	105.9	423.4	235.0	356.4	72.9
0604	111.9	139.7	47.7	105.0	407.9	219.2	339.3	71.2
0605	109.2	131.1	46.4	104.9	407.0	233.6	350.7	71.2
0606	105.1	130.7	47.7	104.7	399.7	220.4	340.2	69.5
0607	93.0	126.1	44.6	99.9	382.9	207.9	332.4	69.3
0608	79.7	117.9	39.1	81.8	348.2	195.0	295.7	62.6
0609	93.6	117.2	40.5	88.8	351.1	187.2	292.3	60.9
0610	102.1	132.8	42.3	95.6	372.4	203.1	305.1	62.6
0611	102.1	122.4	43.9	94.2	366.9	199.9	298.4	43.6
0612	97.2	124.6	43.9	96.7	378.9	206.6	307.6	50.9
0613	74.0	104.9	36.3	79.3	320.6	149.4	254.8	1.7
0614	100.7	124.0	40.5	94.4	378.4	203.4	306.0	62.6
0615	100.6	121.9	43.7	99.5	380.7	211.5	324.0	67.5
0616	107.2	126.1	44.3	99.5	382.5	211.6	317.4	67.5
0617	94.8	115.7	40.7	89.6	343.7	183.6	282.8	49.5
0618	93.4	113.6	42.3	90.0	350.8	183.1	283.8	47.5
0619	97.0	120.2	42.2	91.6	360.4	194.0	290.7	60.6
0620	101.9	126.0	44.4	99.5	386.3	204.7	309.1	64.0
0621	101.9	127.7	44.3	95.2	386.2	204.6	309.0	57.1
0622	104.8	127.7	45.7	103.2	396.2	212.3	312.8	27.9
0623	100.4	125.9	43.4	95.2	388.8	202.4	315.2	67.2
0624	101.9	127.7	45.7	99.0	393.4	210.5	325.7	68.8
0625	106.9	127.7	45.7	102.0	395.5	218.4	332.0	70.7
0626	108.9	131.8	47.1	103.8	402.9	208.1	330.5	70.5
0627	89.7	113.5	38.5	87.9	352.8	188.0	298.3	62.3
0628	106.9	125.8	44.1	99.0	389.0	204.7	317.4	67.2
0629	110.1	136.1	47.1	103.6	413.0	209.9	320.8	68.9
0630	111.6	141.8	48.9	104.5	405.2	203.4	305.2	39.1
0701	58.3	83.9	36.1	58.8	243.6	159.5	284.6	41.8
0702	72.4	106.2	22.3	11.9	305.9	163.4	265.5	58.7
0703	69.2	64.4	13.6	38.5	225.4	97.2	196.0	−10.1
0704	91.1	108.2	36.9	86.5	337.7	174.2	246.5	122.2
0705	91.3	91.6	22.8	87.6	335.1	185.7	274.7	112.5
0706	90.0	117.2	38.0	65.5	218.4	170.7	255.5	121.2
0707	94.2	119.3	41.4	87.7	344.5	176.6	264.1	150.9
0708	47.0	88.8	38.4	86.4	337.9	150.8	249.0	115.0
0709	89.0	111.8	33.9	69.9	342.0	178.0	275.9	123.0
0710	96.7	117.9	34.8	69.8	363.1	185.5	251.3	151.9
0711	91.6	96.9	36.4	93.5	357.4	192.7	264.2	107.1
0712	97.1	104.7	39.1	96.6	354.5	198.7	285.8	128.5
0713	95.5	102.7	39.1	93.6	352.6	198.7	284.7	128.5
0714	92.8	107.8	40.3	99.0	368.8	198.1	271.8	18.7
0715	92.9	104.7	39.1	96.6	360.5	196.9	259.1	−32.8
0716	94.1	106.0	41.5	97.4	361.8	199.8	271.0	147.0
0717	89.4	102.4	39.1	96.6	351.2	188.4	230.7	9.2

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Figure 59: URGWOM Consumptive Use - All Reaches